INSTRUCTION MANUAL

ID No. SPARE MANUAL
– RETURN TO –
INSTRUMENT CONTROL
SYLVANIA SES -- West

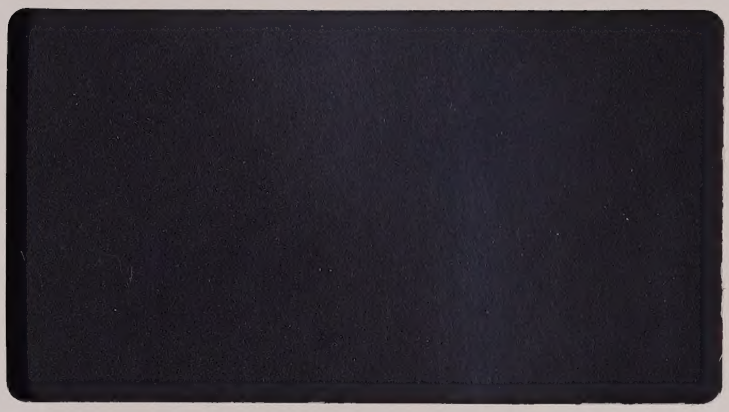
Panoramic*

NARROW-BAND

SPECTRUM ANALYZER

MODEL SSB-4

SINGER
INSTRUMENTATION



INSTRUCTION MANUAL

ID No. SPARE MANUAL
– RETURN TO –
INSTRUMENT CONTROL
SYLVANIA SES -- West

Panoramic*

NARROW-BAND

SPECTRUM ANALYZER

MODEL SSB-4

Replacement Manual Rx 9-68
for S/N 1125848
Ref WO 57850
Acct 19

SINGER
INSTRUMENTATION

Precision electrical and electronic instruments for measurement

emc — EMPIRE* — Gertsch* — Panoramic* — Sensitive Research*

THE SINGER COMPANY • METRICS DIVISION

*A Trademark of THE SINGER COMPANY

WARRANTY

THE SINGER COMPANY, METRICS DIVISION, warrants each new instrument to be free from defects in material and workmanship, effective after delivery to the original purchaser as follows:

*Sensitive Research** Electrical Indicating Instruments.....2 years
Other Electrical and Electronic Measuring Instruments.....1 year

Repair or replacement (at our option) without charge (F.O.B. factory) will be effected when our examination satisfactorily indicates that defects are due to workmanship or materials. Electron tubes, semiconductors, batteries, fuses, lamps, thermoelements, and *RatioTran** potentiometers are excluded from warranty coverage. Warranty returns must first be authorized by the factory.

If the instrument or any portion thereof, has been abused, misused, damaged by accident or negligence, or if any serial number or seal has been removed or altered, the warranty is void.

This warranty is in lieu of all other obligations or liabilities expressed or implied and The Singer Company neither assumes, nor authorizes any person to assume for them, any other liability in connection with sales of instruments manufactured by The Singer Company, Metrics Division.

THE SINGER COMPANY • METRICS DIVISION
915 PEMBROKE STREET, BRIDGEPORT, CONNECTICUT • 3211 S. LA CIENEGA BLVD., LOS ANGELES, CALIFORNIA

*A Trademark of THE SINGER COMPANY

REPAIR AND MAINTENANCE

Instruments should be returned only on prior written authorization from the Singer Representative or the factory(1). Warranty repair will be made upon written request. Please provide the following information in order to expedite our processing of your instrument:

1. Model or Type
2. Serial Number
3. Description of trouble(2)
4. Test instruments used
5. Approximate date instrument was placed in operation
6. Approximate number of hours of use
7. Has maintenance action been previously requested?
8. Other comments

Upon receipt of this information our Service Department will send you service data or shipping instructions. Upon receipt of shipping instructions forward the instrument to the factory prepaid. If requested, an estimate of charges will be made before work begins.

(1) Contact Metrics Division, Bridgeport, Connecticut for *Empire**, *Panoramic**, and *Sensitive Research** instruments. Contact Metrics Division, Los Angeles, California for *Gertsch** instruments.

(2) Include data on symptoms, measurements taken, suspected location of trouble, maintenance action taken, and any other relevant data.

ADDENDUM

FOR

MODELS SSB-3b & SSB-4

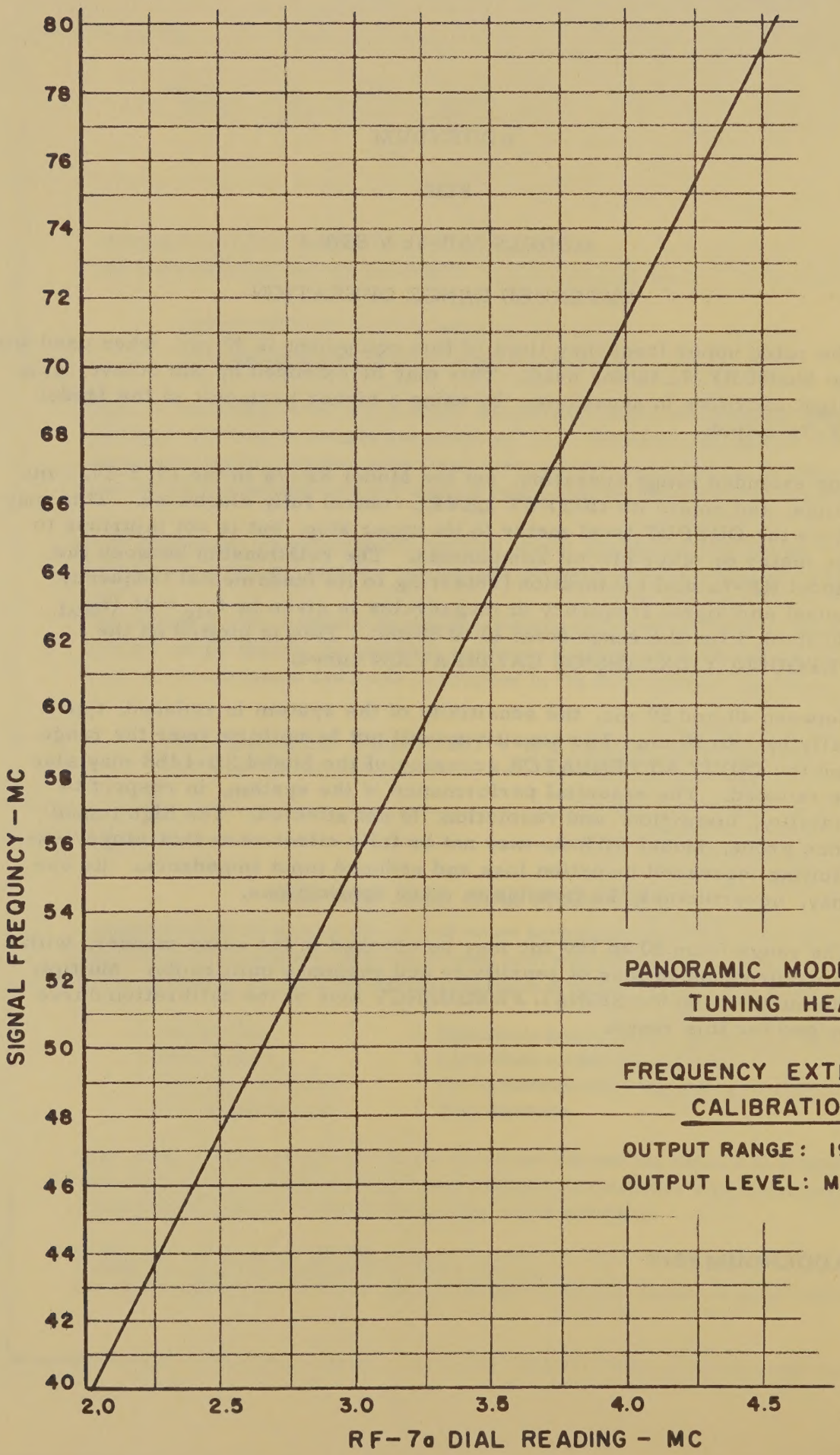
EXTENDED RANGE OPERATION

The rated upper frequency limit of this equipment is 40 mc, when used with the Model RF-7a tuning head. This may be extended by one octave, at a slight sacrifice in sensitivity, by using a higher harmonic of the Model RF-7a output.

For extended range operation, set the Model RF-7a to the 19.5-39.5 mc range, and rotate its OUTPUT LEVEL control fully clockwise. This may drive the OUTPUT level meter to its upper stop, but is not injurious to the meter or other circuit components. The relationship between the Model RF-7a dial calibration (referring to its fundamental frequency range) and signal frequency in megacycles is given by $f_{sig} = 16\ (f_{dial} +0.5) -0.5$ for the range from 40 to 80 mc. This is plotted on the FREQUENCY EXTENSION CALIBRATION curve.

Between 40 and 80 mc, the sensitivity of the system is reduced, typically by 3 to 10 db. The sensitivity will not be uniform over the range, and the INPUT ATTENUATOR accuracy of the Model SB-12bS may also be reduced. The essential performance of the system, in respect to stability, distortion, and resolution, is not affected. The high impedance probe, Model PRB-2, may not be fully effective in this range, exhibiting increased insertion loss and reduced input impedance. Its use may, nevertheless, be feasible in many applications.

The range from 80 to 160 mc may be covered in the same manner, with a more pronounced loss of sensitivity and response uniformity. Multiply the numbers on the SIGNAL FREQUENCY axis of the calibration curve by two for this range.


80
78
76
74
72
70
68
66
64
62
60
58
56
54
52
50
48
46
44
42
40
SIGNAL FREQUNCY - MC
2.0
2.5
3.0
3.5
4.0
4.5
RF-7a DIAL READING - MC
PANORAMIC MODEL RF-7a
TUNING HEAD
FREQUENCY EXTENSION
CALIBRATION
OUTPUT RANGE: 19.5 - 39.5 MC
OUTPUT LEVEL: MAXIMUM

ADDENDUM

for

MODEL SSB-3b

I. PURPOSE.

To correct errors in the List of Replaceable Parts.

II. ADDENDUM.

The data noted below appears incorrectly in the List of Replaceable Parts for Model SSB-3b. Make changes as required.

Ref Symbol	Description	Mfr's Part No.	Mfr's Code	Maint Qty
C103	Capacitor, fixed, paper, 0.1UF, 400 V Singer Part No. 556120-099	330701	00853	1

Addendum No. 439

ADDENDUM

for

MODELS SSB-3b & SSB-4

Make the following change on page 73 of the List of Replaceable Parts.

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
S403	SWITCH, TOGGLE SINGER PART NO. 556162-866	Type PA222	71590	

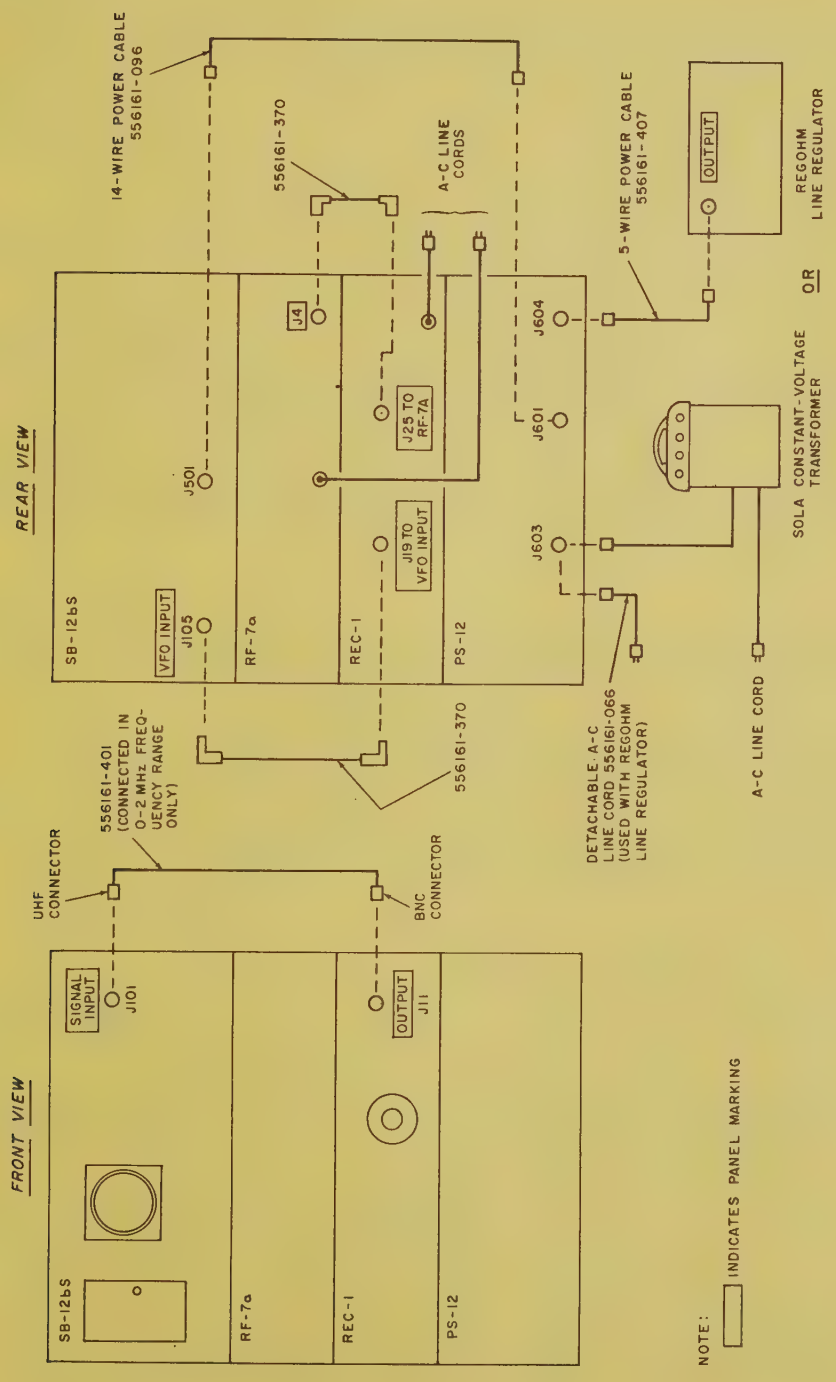
Add this entry to the Manufacturer's Code Column.

Code	Manufacturer
71590	Centralab Division of Globe-Union Inc. Milwaukee, Wis.

Addendum No. 521

ADDENDUM
for
MODEL SSB-4 NARROW BAND SPECTRUM ANALYZER

When interconnecting the units of the SSB 4, refer to the interconnecting diagram below:



ADDENDUM
for
MODELS SSB-3b and SSB-4
S/N U11963, U11966, U11967, U11969,
U11974, U11975, U11977 thru U11985,
and U11987 and up

I. PURPOSE.

To reflect changes in instruction manual due to change in supplied equipment.

II. ADDENDUM.

Incorporate the following changes into the Model SSB-3b instruction manual.

a. In paragraph I-3:
   (1) Change the second entry to read "Tuning Head, Model RF-8R;"
   (2) Change the seventh entry to read "Cable, Interconnecting, 14 wire, 556161-326;"
   (3) Change the eighth entry to read "Cable Coaxial, 556161-036;"
   (4) Change the ninth entry to read "Line Cord, A-c, PS-21, 556161-006."

b. In chapters I and II:
   (1) Change all references to the Model RF-7a to read "RF-8R;"
   (2) Change all references to the tuning head FREQUENCY RANGE switch to read "RANGE switch;"
   (3) Change all references to the tuning head MAIN TUNING control to read "Tuning control;"
   (4) Change all references to the tuning head MAIN TUNING dial to read "MHz dial;"
   (5) Delete all references to the tuning head OUTPUT LEVEL control and/or meter.

c. Delete paragraph I-4.3. Refer to Model RF-8 manual for description of tuning head.

d. Delete paragraph I-5.3. Refer to Model RF-8 manual for tuning head specifications.

e. Delete paragraph I-7.3. Refer to Model RF-8 manual for tuning head transistor and diode complement.

f. Delete figure I-5. Refer to figure 2-3 in Model RF-8 manual.

g. Delete paragraph I.8.3. Refer to table 2-1 in Model RF-8 Manual.

h. In table II-1, change fifth row to read:

Coaxial cable, with 2 series BNC connectors, 3ft. long, 556161-036	RF-8R rear chassis	VFO INPUT, SB-12bS rear chassis

i. In paragraph II-3.3:

(1) Delete subparagraph a. and change subparagraph b. to read "a."
(2) Delete subparagraph c.
(3) Change subparagraph d. through h. to read b. through f., respectively.

j. Delete paragraph IV-1.3. Refer to Section III of Model RF-8 manual for theory of operation.

k. Delete figure IV-3. Refer to figure 3-1 of Model RF-8 manual for tuning head block diagram.

l. Delete paragraph V-5.3. Refer to Section IV of Model RF-8 manual for troubleshooting procedures.

m. Delete paragraph V-6.3.

n. Delete paragraph V-7.3. Refer to Section IV of Model RF-8 manual for alignment procedures.

o. Delete table V-8. Refer to Section VI of Model RF-8 manual for parts list.

p. Delete RF-7a Tuning Head Schematic. Refer to figure 5-1 of Model RF-8R manual for tuning head schematic diagram.

q. Change table V-11 to read as follows:

TABLE V-11 PARTS LIST (ACCESSORY)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
	TRANSFORMER, REGULATING, 50CPS, 220VAC (SELECT AS REQUIRED)	556020-046	16665	
	TRANSFORMER, REGULATING, 50CPS, 115VAC (SELECT AS REQUIRED)	556020-064	16665	

TABLE V-11 PARTS LIST (ACCESSORY) (Cont'd)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
	TRANSFORMER, REGULATING, 60CPS, 115VAC (SELECT AS REQUIRED)	556020-162	16665	
	ADAPTER, CONNECTOR SINGER P/N556010-230	228	71700	
	CABLE ASSY (3FT.) CABINET UNITS ONLY	102-9200-111	16665	
	AC LINE CORD (6FT.) CABINET UNITS ONLY	556161-066	16665	
	POWER CABLE ASSY (3FT.) CABINET UNITS ONLY	556161-326	16665	
	POWER CABLE ASSY (3FT.) RACK MOUNTED UNITS ONLY	556161-096	16665	
	CABLE ASSY (6FT.) RACK MOUNTED UNITS ONLY	102-9200-112	16665	
	CABLE ASSY (3FT.) SSB-4 CABINET UNIT ONLY	102-9200-091	16665	
	CABLE ASSY (6FT.) SSB-4 RACK MOUNTED UNIT ONLY	102-9200-090	16665	
	CABLE ASSY (6FT.) SSB-4 CABINET AND RACK MOUNTED UNITS ONLY	102-9200-120	16665	

ADDENDUM

for

MODELS SSB-3b & SSB-4

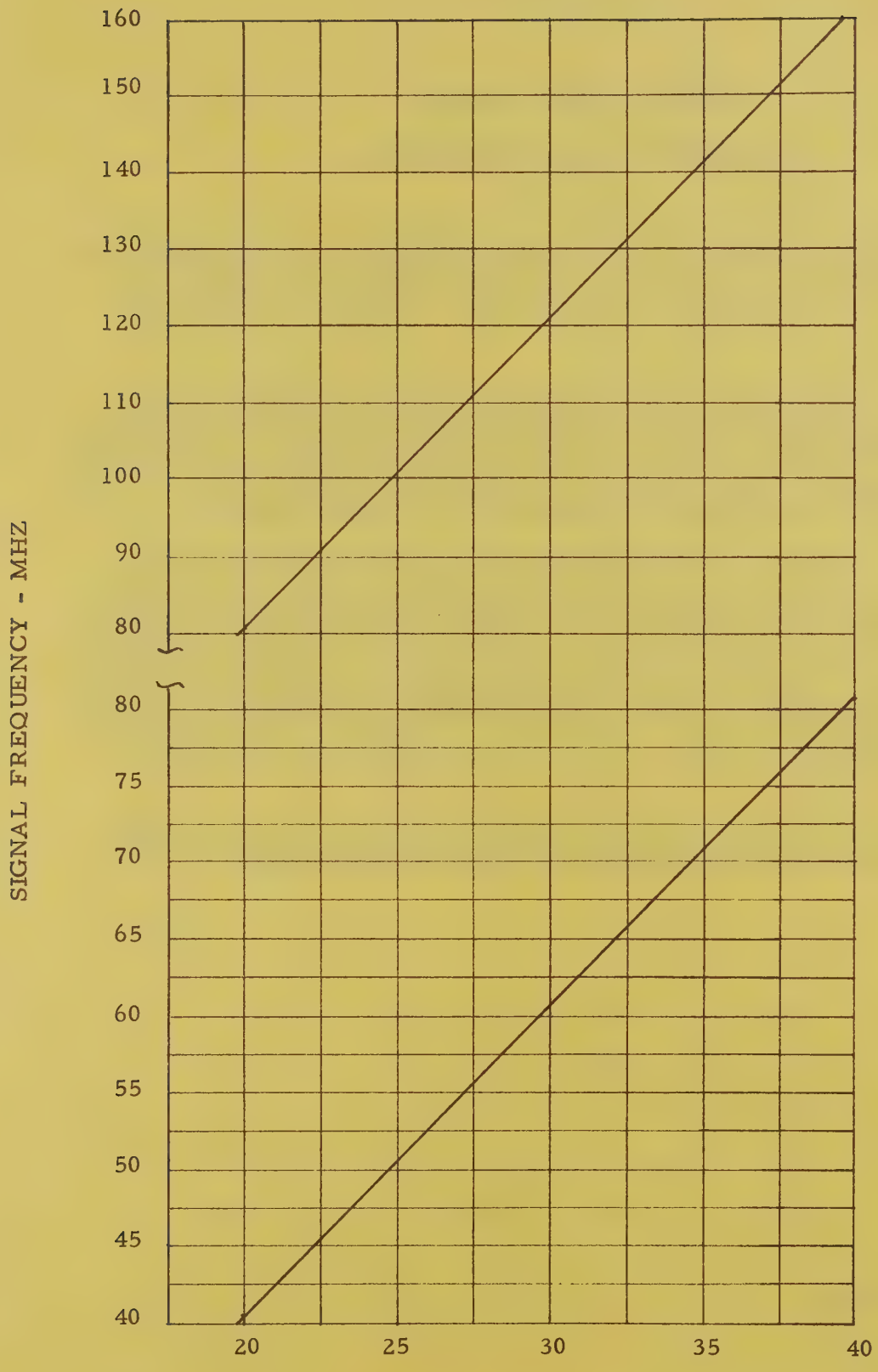
EXTENDED RANGE OPERATION

The rated upper frequency limit of this equipment is 40 mc when used with the Model RF-8R tuning head. This may be extended by one octave, at a slight sacrifice in sensitivity, by using a higher harmonic of the Model RF-8R.

For extended range operation, set the Model RF-8R to the 19.5-40 mc range. The relationship between the Model RF-8R dial calibration (referring to its fundamental frequency range) and signal frequency in megacycles is given by $f_{sig} = 2\ (f_{dial} + 0.5) - 0.5$ for the range from 40 to 80 mc. This is plotted on the FREQUENCY EXTENSION CALIBRATION curve.

Between 40 and 80 mc, the sensitivity of the system is reduced, typically by 3 to 10 db. The sensitivity will not be uniform over the range, and the INPUT ATTENUATOR accuracy of the Model SB-12bS may also be reduced. The essential performance of the system in respect to stability, distortion, and resolution, is not affected. The high impedance probe, Model PRB-2, may not be fully effective in this range, exhibiting increased insertion loss and reduced input impedance. Its use may, nevertheless, be feasible in many applications.

The range from 80 to 160 mc may be covered in the same manner, with a more pronounced loss of sensitivity and response uniformity.



FREQUENCY EXTENSION CALIBRATION

TABLE OF CONTENTS

Page

CHAPTER I—INTRODUCTION

I-1. General 1
I-2. Applications 1
I-3. Equipment Supplied 1
I-4. General Description, Model SSB-3b 1
I-4.1. General Description, Model SB-12bS 2
I-4.2. General Description, Model TTG-2 2
I-4.3. General Description, Tuning Head, Model RF-7a 3
I-4.4. General Description, Model PRB-2 3
I-5. Electrical Specifications, Model SSB-3b 3
I-5.1. Electrical Characteristics, Model SB-12bS 4
I-5.2. Electrical Characteristics, Model TTG-2 5
I-5.3. Electrical Characteristics, Model RF-7a 5
I-5.4. Electrical Characteristics, Model PRB-2 5
I-6. Physical Characteristics, Model SSB-3b 6
I-7. Tube and Transistor Complement, Model SSB-3b 6
I-7.1. Tube and Transistor Complement, Model SB-12bS 6
I-7.2. Tube Complement, Model TTG-2 7
I-7.3. Tube Complement, Model RF-7a 7
I-7.4. Tube Complement, Model PRB-2 8
I-8. Front Panel Controls 8
I-8.1. Front Panel Controls, Model SB-12bS 8
I-8.2. Front Panel Controls, Model TTG-2 12
I-8.3. Front Panel Controls, Model RF-7a 12

CHAPTER II—INSTALLATION

II-1. Initial Inspection 13
II-2. Interconnecting Procedure 13
II-3. Installation Adjustments and Checks 13
II-3.1. Installation Adjustments and Checks, Model SB-12bS 14
II-3.2. Installation Adjustments and Checks, Model TTG-2 16
II-3.3. Installation Adjustments and Checks, Model RF-7a 16

CHAPTER III—OPERATION

III-1. General Operation 19
III-2. Single Sideband Analysis 20
III-3. Narrow Band Analysis 21
III-4. Operation of Model SB-12bS with Model RC-3b Recorder 23
III-5. Interpretation of Signals 23

CHAPTER IV—THEORY OF OPERATION

IV-1. Circuit Description 27
IV-1.1. Model SB-12bS 27
IV-1.2. Circuit Description, Model TTG-2 33
IV-1.3. Tuning Head, Model RF-7a 34
IV-1.4. High Impedance Probe, Model PRB-2 37

CHAPTER V—SERVICE AND MAINTENANCE

V-1. General 39
V-2. Inspection and Component Replacement 39
V-3. Recommended Test Equipment 39

TABLE OF CONTENTS (cont.)

Page

V-4. Screwdriver-Adjust Controls 40
V-4.1. Screwdriver-Adjust Controls, Model SB-12bS 40
V-4.2. Screwdriver-Adjust Controls, Model TTG-2 42
V-4.3. Screwdriver-Adjust Controls, Model RF-7a 42
V-5. Troubleshooting and Touch-Up Alignment 42
V-5.1. Touch-Up Alignment, Model SB-12bS 42
V-5.2. Troubleshooting, Model TTG-2 43
V-5.3. Troubleshooting, Model RF-7a 43
V-6. Voltage and Resistance Charts 44
V-6.1. Voltage and Resistance Charts, Models SB-12bS and PS-21 . . 44
V-6.2. Voltage and Resistance Chart, Model TTG-2 48
V-6.3. Voltage and Resistance Chart, Model RF-7a 48
V-7. Alignment Procedure 48
V-7.1. Alignment Procedure, Model SB-12bS 48
V-7.2. Alignment Procedure, Model TTG-2 53
V-7.3. Alignment Procedure, Model RF-7a 53
V-8. List of Replaceable Parts 54
V-8.1 Ordering Information 54
V-8.2 How to Use the Parts List 55

LIST OF ILLUSTRATIONS

CHAPTER I—INTRODUCTION

Figure	Title	Page
	Panoramic Single Sideband Spectrum Analyzer, Model SSB-3b	Frontispiece
I-1.	Resolution Versus Sweep Width	6
I-2.	Minimum Frequency Separation Required to Measure Amplitude Ratios E_2/E_1	6
I-3.	Front Panel, Model SB-12bS	10
I-4.	Front Panel, Model TTG-2	11
I-5.	Front Panel, Model RF-7a	11

CHAPTER II—INSTALLATION

II-1.	Outline Dimensional Drawing, Model SSB-3b, in Cabinet	17
II-2.	Outline Dimensional Drawing, Constant-Voltage Transformer T3003A-1	18

CHAPTER III—OPERATION

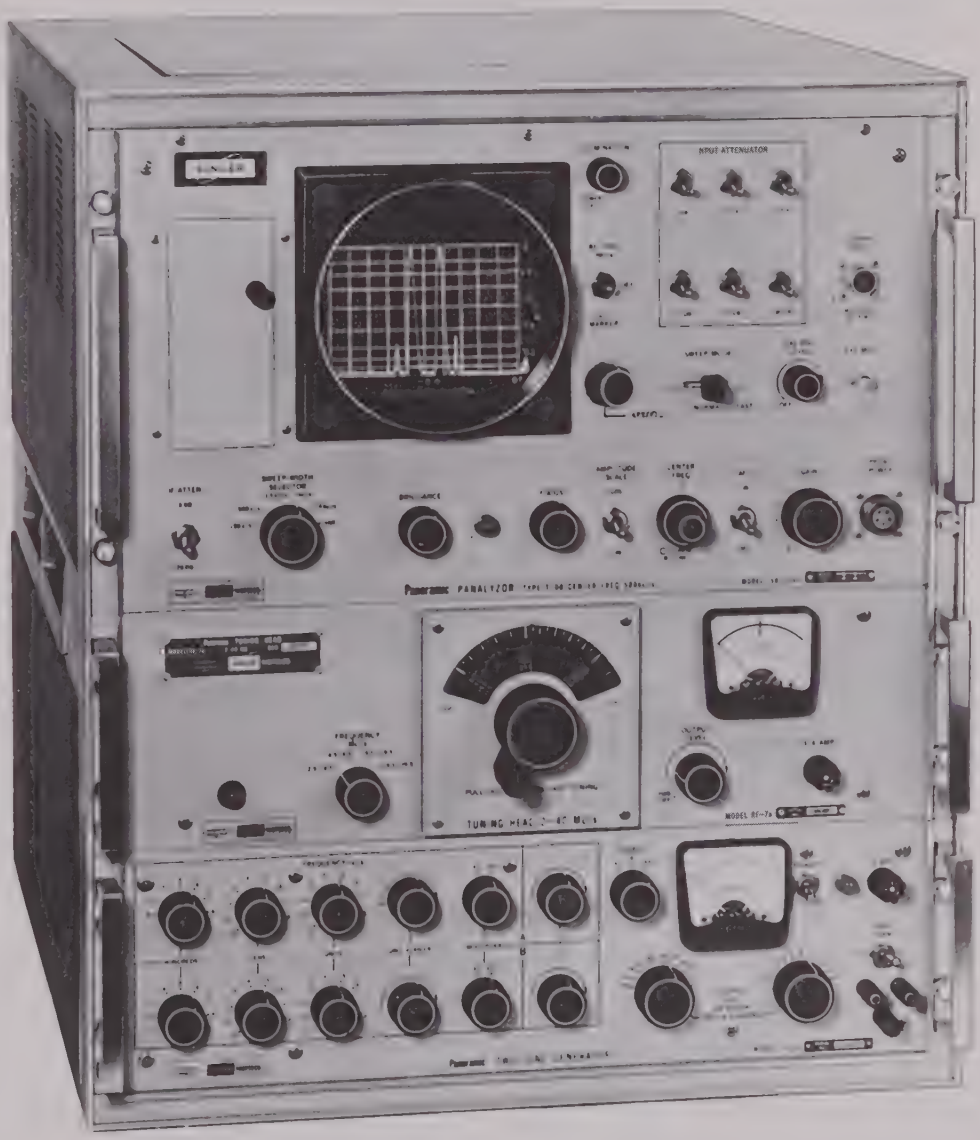
III-1.	Block Diagram of Two Tone Test	20
III-2.	Two Tone Test	21
III-3.	Ringing as an Indication of Optimum Resolution	22
III-4.	Screen Presentation of Constant Carrier Signal	24
III-5.	Screen Presentations of Amplitude-Modulated Signals	24
III-6.	Resolution of Interfering Signals	25
III-7.	Screen Presentation of Frequency-Modulated Signals	25

CHAPTER IV—THEORY OF OPERATION

IV-1.	Block Diagram, Model SB-12bS	28
IV-2.	Block Diagram, Model TTG-2	35
IV-3.	Block Diagram, Model RF-7a	36

CHAPTER V—SERVICE AND MAINTENANCE

V-1.	Voltage and Resistance Chart, Model SB-12bS	45
V-2.	Voltage and Resistance Chart, Model PS-21	46
V-3.	Voltage and Resistance Chart, Model TTG-2	47
V-4.	Crystal Rejection Slot Removal	50
V-5.	Parts List Sample	55



Panoramic Single Sideband Spectrum Analyzer, Model SSB-3b.

CHAPTER I
INTRODUCTION

I-1. GENERAL

This Instruction Manual has been prepared to assist in the installation, operation and servicing of the Panoramic Single Sideband Spectrum Analyzer, Model SSB-3b.

No attempt to operate the equipment should be made until the operator is thoroughly familiar with the information contained in CHAPTER III - OPERATION.

I-2. APPLICATIONS

The Model SSB-3b is designed for research, design or production test applications such as:

Rapid analysis of in-band distortion of SSB transmitters and exciters by two tone test method (to -60 db).

Measurement of suppressed carrier levels, residual unwanted sidebands. Monitor transmission bandwidths.

Hum sideband studies (e.g., ±60 cps component readily analyzed down to -60 db).

Out of band signal studies of harmonics, cross products, parasitics, etc.

Ideal for virtually any narrow band r-f studies of up to ±50 KC as in AM, FM, PM and multiplexed channels.

I-3. EQUIPMENT SUPPLIED

Description	Quantity
Panalyzor, Model SB-12bS, Type T-100	1
Tuning Head, Model RF-7a	1
Two-Tone Generator, Model TTG-2	1
Power Supply, Model PS-21*	1
Cabinet	1
Transformer, Constant-Voltage, T-3003A-1	1
Cable, Interconnecting, 14 wire, W74-36	1
Cable, Coaxial, W13-36	1
Line Cord, a-c, PS-21, W4-72	1
Probe, High Impedance, Model PRB-2	1
Spare Fuse, 2 Amp, 250 V, Slow-Blow (in equipment)	3
Tool, Alignment, E1010	1

* Model PS-12 supplied with rack mount equipments.

I-4. GENERAL DESCRIPTION, MODEL SSB-3b

The Model SSB-3b is an instrument designed for r-f spectrum analysis especially in narrow band communications systems. For the widely used two tone tests of transmitter networks, the SSB-3b supplies the required input signals, directly calibrated readout, and is self-checking to insure reliable results. The spectrum analyzer section of the SSB-3b is the improved Panalyzor, Model SB-12bS. The other components of the SSB-3b, which make it an all-inclusive measurement device, are a specially designed Tuning Head, Model RF-7a, a two tone audio signal generator, Model TTG-2, and a transmitter-simulating two r-f tone source for self-checking. An optional Range Extending Converter, Model REC-1, is available. In use, the frequency dial of the Model RF-7a Tuning Head is set to the center of the spectrum of interest. Its output is mixed with the input signal in the broad band converter of the SB-12bS. Since the SB-12bS always scans a region about a 500 KC center, the tuning head calibration is marked at 500 KC above the actual frequency generated. The Tuning Head output is stable and free from spurious frequencies so that it does not affect the subsequent analysis accuracy. A 49 db attenuator in 1 db steps is included in the signal input circuit to implement handling of large amplitudes.

With the optional Range Extending Converter, Model REC-1, receiver outputs, i-f's, multiplexed channels, etc., within the range of 100 cps to 2 MC are translated up in frequency and analyzed on the SB-12bS crt screen. The Model REC-1 includes heterodyne and frequency selective networks to insure linearity to -60 db.

Preset operating modes on the SB-12bS are designed to simplify analysis by automatically taking care of such manipulations as adjusting sweep width, gain, i-f bandwidth (resolution) and sweep rate. By choosing one of the preset sweep widths, i.e., 150, 500, 3,500, 7,000 and 14,000 cps, the other parameters are tracked so as to optimize the analysis. For example, on the 150 cps sweep width, a relatively slow scan rate of 10 sec/scan, AFC, stabilizing, and a narrow i-f filter bandwidth are switched in. On such magnified views, the "quick look" circuit speeds up the sweep to 1 scan/second for aid in signal location on a qualitative basis. Release of the switch returns the settings to the optimized values. An additional manual sweep mode permits positioning of the CRT spot by the operator at any point of interest. Full range continuous adjustments of sweep widths, sweep rate, and i-f bandwidth are provided in the VAR(iable) operation mode.

The vertical amplitude calibrations are logarithmic and linear as selected by a front panel switch. The log calibration of 0 to -40 db is extended to the -20 db to -60 db range by a switch when signals between -40 db and -60 db are to be measured. The SSB-3b is designed with reliable and linear input networks which permit full 60 db range tests. Residual hum is suppressed at least 60 db.

The SB-12bS includes a 5ADP7 cathode-ray tube. Adjustable edge lighting on the calibrated crt scale is provided. The camera mount bezel will accept standard oscilloscope cameras. A graphic pen and ink recorder, the Panoramic Model RC-3b, is available, when unattended analysis and permanent records are desired. Each scan using the RC-3b results in a 12" x 4-1/2" chart. Minimum RC-3b sweep interval for recording is 1 minute.

I-4.1. GENERAL DESCRIPTION, MODEL SB-12bS.

The Panalyzor, Model SB-12bS, is an automatic scanning superheterodyne receiver which permits analysis and identification of one or many radio-frequency signals at one time. Each signal within the band being scanned is displayed on a cathode-ray tube as one of a series of inverted V's or "pips". The pip amplitude and position along the calibrated horizontal axis are indicative of signal level and frequency, respectively. A CW signal produces a single pip. Modulated signals (AM, FM or pulsed) cause a series of pips which indicate sideband distribution and levels.

The Model SB-12bS provides two modes of operation divided into seven ranges.

The variable sweep width mode of operation provides a 0 - 100 KC variable sweep width for search and preliminary analysis and a 0 to 2 KC variable sweep width with automatic frequency controlled sweep for detailed analysis.

The pre-set mode of operation provides pre-set, narrow band, sweep widths of 14 KC, 7 KC, 3.5 KC, 500 cps and 150 cps for slow speed, highly resolved analysis. The 500 cps and 150 cps sweep widths are AFC stabilized.

The Model SB-12bS provides visual means of examining such parameters as the effects of power supply fluctuations, thermal changes, humidity, component variations, shock, vibration and load changes upon frequency. Both magnitude and direction of frequency drift are indicated. Parasitic oscillations which normally may pass unnoticed can quickly be detected and identified. Spurious modulation by subsonics, hum and noise are readily spotted. In single sideband linearity tests, the Model SB-12bS permits in-band intermodulation distortion readings to -60 db.

Because of its Panoramic presentation the instrument is invaluable for monitoring a frequency band for the appearance, disappearance and shift of signals. Highly useful graphic displays of such phenomena as Bessel function distributions of FM signals, energy distribution of pulsed r-f signals with low prf's, AM sidebands, etc., can be obtained.

The Model SB-12bS is unique in that it offers all the advantages of automatically scanning spectrum presentations, yet enables examination of signals so closely adjacent in frequency that their corresponding deflections normally tend to merge together or even completely mask one another. The instrument can, at reduced sweep widths and slow sweep rates, resolve equal amplitude signals down to 10 cps separation. Manual scan permits placement of CRT spot at any location for even more efficient resolution. Signals with an amplitude ratio of 60 db separated by 60 cps are clearly separated. (See Figures I-1 and I-2, Resolution E_2/E_1 Graphs.)

I-4.2. GENERAL DESCRIPTION, MODEL TTG-2.

The Panoramic Two-Tone Generator, Model TTG-2, contains two independent low-distortion audio oscillators and a passive mixing circuit. Each oscillator covers the range 100 - 10,000 cps, with digital frequency selection and a continuous interpolation control. The output of either oscillator, or both outputs combined, may be connected to the front panel OUTPUT terminals by means of a selector switch. The amplitude of the selected output signal is read on a front panel meter, calibrated in volts and dbm (referred to 1 milliwatt in 600 ohms). The level of each oscillator is individually adjustable between two and four volts rms. A precision output attenuator provides up to 110 db of attenuation in 1 db steps. The output impedance is essentially constant at 600 ohms.

The primary application of the Model TTG-2 is for modulating a single-sideband suppressed carrier (SSB) transmitter in order to measure the third order (in-band) distortion generated in the transmitter. This measurement is usually referred to as a "two-tone test".

A single tone may be used to modulate a conventional AM transmitter for measurement of non-linear distortion in the audio stages and the modulated amplifier.

I-4.3. GENERAL DESCRIPTION, TUNING HEAD, MODEL RF-7a.

The Tuning Head, Model RF-7a, is a highly stable, continuous tuning oscillator-multiplier unit de-

signed to provide local injection signals over the range of 2.5 to 39.5 MC for the Model SSB-3b. It consists of a precision inductance-tuned variable-frequency oscillator and several frequency multiplier stages and is contained, complete with power supply, in a standard, completely shielded, relay rack mounting unit which occupies a rack height (panel space) of 5-1/4 inches.

The range of signal frequencies generated by the unit is divided into four bands, harmonically related. The controls provided are the band range switch, main tuning and output level control. The output level is monitored by means of an integral panel-mounted meter. Special attention has been given to oscillator frequency stability and low spurious radiation, thus making the unit particularly suitable for use in single-sideband transmitter measurements.

A two speed tuning drive facilitates rapid frequency changes, while retaining the slow, backlash-free tuning needed for final tuning of the Model RF-7a.

I-4.4. GENERAL DESCRIPTION, MODEL PRB-2.

The Cathode Follower, Model PRB-2, permits connection of signals from a high-impedance source to the Panoramic Panalyzor, Model SB-12bS.

The complete probe consists of a cathode follower section, three attenuator heads (a 20 db head, a 40 db head, and a 60 db head), and three test points (a straight point, a hooked point, and an alligator-clip point).

I-5. ELECTRICAL SPECIFICATIONS, MODEL SSB-3b

a. Sweep Widths and Sweep Rates.

	Preset					Variable
Sweep Width	150 cps	500 cps	3.5 kc	7 kc	14 kc	(0-100 kc and 0-2 kc with AFC)
Sweep Rate (cps):	0.1*	0.1*	1	1	1	(0.1 - 30)
Resolution (3 db down):	10 cps	18 cps	150 cps	220 cps	350 cps	(10 cps to 1.8 kc)
Minimum frequency separation for measurements 60 db down:	60 cps	100 cps	600 cps	900 cps	1.4 kc	

*May be speeded up to 1 cps by panel mounted lever switch to facilitate location of signals. AFC circuit used.

b. Frequency Range: (with Tuning Head, Model RF-7a) 2 MC to 40 MC.
(with Range Extending Converter, Model REC-1) 10 cps to 2 MC.

c. Input Attenuator: Up to 49 db in 1 db steps. Continuous 20 db gain control.

d. Probe Attenuators: 20, 40 and 60 db. (Screw-on type.)

e. Sensitivity: (At 50 ohm signal input.) Less than 2 mv full scale log (with .3 V output from Tuning Head, Model RF-7a).

With High Impedance Probe, Model PRB-2 - Insertion loss approximately 10 db at 2 MC.

f. Input Impedance: 50 ohms. With High Impedance Probe, Model PRB-2, 12 megohms shunted by 5 uuf.

g. Amplitude Scales: Linear and 40 db range log, selectable by front panel switch. The front panel 20 db IF ATTENUATOR may be used to extend calibrated range to 60 db.

h. Dynamic Amplitude Range: (Two-Tone Test) All in-band residual (odd order intermodulation products better than 60 db below the level of two equal amplitude reference signals deflected 20 db above full scale on log amplitude.

i. Residual Hum Level: Sidebands due to power line frequencies suppressed more than 60 db.

j. Internal Self-Checking Features: Two crystal controlled oscillators, 3000 KC and 3002 KC.

500 KC (center frequency) crystal controlled oscillator with AM input terminals for sweep width checks.

5 KC marker oscillator for internal modulation of 500 KC crystal calibrating oscillator.

k. Auxiliary Outputs: Vertical amplitude and horizontal frequency output terminals are provided.

l. CRT Indicator: A 5" high persistence crt (5ADP7) with scale illumination and a standard oscilloscope camera mounting bezel.

m. Optional Indicator: Automatically inked paper recorder, Model RC-3b. Chart size 12" x 4-1/2", recording scan intervals when using RC-3b, 1 minute - 16 minutes.

n. Two-Tone Signal Generator: Model TTG-2 consisting of two independent audio oscillators with outputs combined in linear mixer.

1. Oscillator Frequencies: Each oscillator, 100 cps - 10 KC, continuously adjustable.

2. Output Level: Up to 4 volts rms per tone into 600 ohm balanced load. Up to 2 volts per tone into unbalanced load.

3. Output Selection: The two tones may be switched on and off independently, without interaction. Individual level adjustments are provided so that the two tones may be set to the same amplitude.

4. Output Attenuator: Precision attenuators provide up to 110 db attenuation in 1 db steps.

5. Distortion: All harmonic and intermodulation products are down at least 60 db from either output tone as analyzed on SSB-3b screen.

o. Power Consumption: Approximately 300 watts.

p. Power Sources: 105 to 125 volts, 47.5 to 450 cps. (A line regulator is supplied with the SSB-3b which allows operation from 95 to 125 volts, 60 cycles, with improved stability.) At other power line frequencies, special regulators are available.

I-5.1. ELECTRICAL CHARACTERISTICS, MODEL SB-12bS.

a. Sweep Widths.

	SWEEP WIDTH	MODE
AFC Stabilized	0 - 100 KC	Continuously variable
	0 - 2 KC	Continuously variable
	150 cps 500 cps	Pre-set with automatically optimum i-f bandwidth (Resolution)
	3.5 KC 7 KC 14 KC	
(Other pre-set sweep widths available upon request.)		

b. Input Center Frequency. 500 KC

c. Bandpass Region (after input mixer). 450 - 550 KC.

d. Bandpass Region Amplitude Characteristic. (450 - 550 KC) Uniform within ±5% or ±1/2 db.

e. Image Rejection. Better than (100 to 1) at input center frequency.

f. Input Impedance. 50 ohms at VFO INPUT jack. 12 megohms shunted by 5 uuf into PRB-2.

g. Input Attenuator. 0 - 49 db attenuation of the input signal in 1 db step. Accuracy ±0.05 db/db to 30 MC.

h. Amplitude Scales. Linear and 2 decade log selectable by front panel switch. A front panel 20 db attenuator may be used to extend calibrated range to 60 db.

i. Direct Sensitivity. Maximum rms voltage (at signal input terminal) in center frequency band (450 - 550 KC) required for full scale linear deflection: 20 uv.

j. Conversion Sensitivity. Maximum rms signal required at signal input terminal for full scale log deflection when 0.3 volts rms from an external signal generator is injected into the VFO input terminal: 200uv. (The signal generator frequency should be adjusted to heterodyne the signal down to the input center frequency band of the Panalyzor.)

k. Input Mixer Range. The SB-12bS input aperiodic mixer is suitable for signals up to approximately 1000 MC. Sensitivity and dynamic range are reduced above 40 MC.

l. Scan Rates. 0.1 cps to 30 cps continuously

variable. On pre-set sweep widths of 150 cps, 500 cps - 0.1 cps scan rate. On pre-set sweep widths of 14 KC, 7 KC and 3.5 KC - 1 cps scan rate.

m. Resolution. Continuously adjustable with IF BANDWIDTH control except on pre-set sweep widths. Range from approximately 3 KC down to less than 10 cps. (Resolution is defined as the frequency separation between two equal adjacent signals such that the intersection between their respective pip indications is 30% below the apex amplitude).

See Figure I-1, Resolution Graph. The Model SB-12bS is capable of 10 cps resolution or better at slow scan rates and reduced sweep widths.

n. Dynamic Amplitude Range (Two-Tone Test). All in-band residual (odd order) intermodulation products better than 60 db below level of two equal reference signals deflected 20 db above full scale log.

o. Internal Self-Checking Features.

1. Two crystal controlled oscillators (RF TEST), 3000 KC and 3002 KC.

2. 500 KC (center frequency) crystal controlled oscillator (CAL OSC) with a-m input terminals for sweep width checks.

3. 5 KC marker oscillator for internal modulation of 500 KC (CAL OSC) crystal controlled calibrating oscillator.

p. Auxiliary Outputs. Vertical amplitude and horizontal frequency output terminals provided. Connector provided for operation with chart recorder, Model RC-3b.

q. Indicator. 5" diameter flat face crt (5ADP7) with edge lit reticle and scale illumination, and a standard oscilloscope camera mounting bezel.

r. Power Consumption. Approximately 180 watts.

s. Power Source. 95 - 125 volt 60 cps. Line regulator supplied. Special regulators available for 220 volts or 50 cps operation.

I-5.2. ELECTRICAL CHARACTERISTICS, MODEL TTG-2.

Oscillator Frequencies:
100 - 10,000 cps

Calibration Accuracy:
± 2%

Maximum Output Level:
4 volts rms per tone

Output Impedance:
600 ohms, balanced to ground

Distortion:
All intermodulation products, harmonics, hum and noise are down more than 60 db referred to the output voltage.

Input Connections:
Integral 6 foot three-wire line cord with plug.

Output Connections:
Output terminals on front panel.

Power Requirements:
105 - 125 volts, 50 - 400 cps, 50 watts

I-5.3. ELECTRICAL CHARACTERISTICS, MODEL RF-7a.

Frequency Range:
2.5 to 40.0 MC, in four bands. The unit is calibrated in signal frequency (i.e., 0.5 MC below the oscillator frequency) as follows:

Band 1 - 2.0 - 4.5 MC
Band 2 - 4.5 - 9.5 MC
Band 3 - 9.5 - 19.5 MC
Band 4 - 19.5 - 39.5 MC

Output Level:
Adjustable - 0 to 0.3 volts (minimum)

Output Impedance:
50 ohms coaxial (mating connector type UG-88/U

Spurious Radiation:
Hum and noise sidebands more than 60 db below fundamental.

Stability:
Better than 10 PPM under normal room temperature conditions. Low-noise oscillator tube used for minimum microphonics.

Power Input:
115 volts, 50/400 cycles a-c, approximately 35 watts.

I-5.4. ELECTRICAL CHARACTERISTICS, MODEL PRB-2.

Frequency Response:
Down less than 6 db at 40 MC

Insertion Loss (at 2 MC):
10 db (approximate)

Input Impedance (less attenuator heads): *
12 megohms shunted by 5 uuf

Maximum permissible total rms input voltage	General	3rd Order Distortion Measurements
Probe less attenuator head	.1 volt	.03 volt
20 db attenuator head (single gold band)	1 volt	.3 volt
40 db attenuator head (double gold band)	10 volts	3 volts
60 db attenuator head (triple gold band)	100 volts	30 volts

* The input impedance will depend on the attenuator head being used. Note also, that the input impedance will decrease appreciably at the higher frequencies because the transit time in the cathode-follower tube becomes a significant factor.

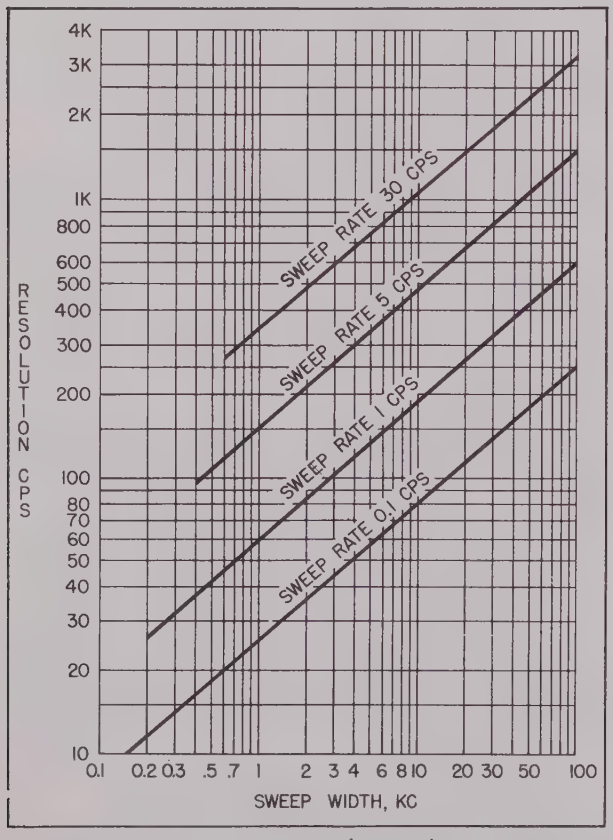


Figure I-1. Resolution (in cps) vs. Sweep Width (in KC).

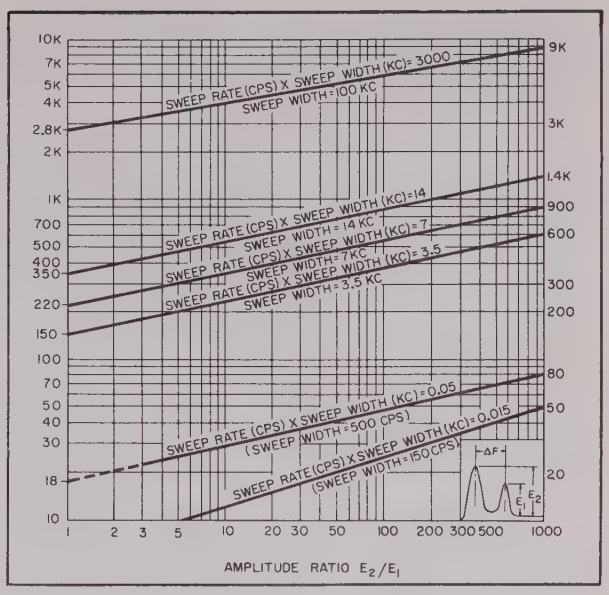

ΔF CPS
SWEEP RATE (CPS) X SWEEP WIDTH (KC)= 3000
SWEEP WIDTH = 100 KC
SWEEP RATE (CPS) X SWEEP WIDTH (KC)=14
SWEEP WIDTH = 14 KC
SWEEP RATE (CPS) X SWEEP WIDTH (KC)= 7
SWEEP WIDTH = 7KC
SWEEP RATE (CPS) X SWEEP WIDTH (KC)= 3.5
SWEEP WIDTH = 3.5 KC
SWEEP RATE (CPS) X SWEEP WIDTH (KC)=0.05
(SWEEP WIDTH = 500 CPS)
SWEEP RATE (CPS) X SWEEP WIDTH (KC)=0.015
(SWEEP WIDTH = 150 CPS)
ΔF
E1
E2
AMPLITUDE RATIO E2/E1

Figure I-2. Minimum Frequency Separation Δf Required to Measure Amplitude Ratios E_2E_1.
Figures in parenthesis represent pre-set sweep widths. The curves represent the electrical resolution of the Model SB-12bS. The dashed portion represents electrical resolution beyond optical resolution. To obtain the results shown in this portion of the curve, an expanded scale oscilloscope or Recorder, Model RC-3b, must be used.

I-6. PHYSICAL CHARACTERISTICS, MODEL SSB-3b

a. Weights.

Description	Weight
Model SSB-3b, in Cabinet	120 lbs
Transformer, Constant-Voltage, T3003A-1	19 lbs

b. Dimensions. See Figure II-1 for Outline Dimensional Data.

Description	Dimension
Probe, Model PRB-2	.3 ft long (cable)

I-7. TUBE AND TRANSISTOR COMPLEMENT, MODEL SSB-3a

I-7.1. TUBE AND TRANSISTOR COMPLEMENT, MODEL SB-12bS.

a. Analyzer Section.

Circuit Reference Symbol	Type	Function
V1	6AF4A	Input Mixer
V2	6922	RF Amplifier
V3	6BE6	2nd Mixer, Local Oscillator
V4	6AH6	Reactance Tube
V5	6BH6	AFC Amplifier
V6	12AL5	Discriminator
V7	6U8	IF Amplifier
V8	6U8	IF Amplifier
V9	6AU6	IF Amplifier
V10	12AU7	Detector; Video Amplifier
V11	12AU7	Amplifier; Cathode Follower
V12	5ADP7	CRT
V13	6AU6	Sweep Tube
V14	12AU7	Blocking Oscillator; Cathode Follower
V15	6BH6	Sweep Discharge Tube
V16	12AU7	Horizontal Deflection Amplifier
V17	5651	Voltage Reference Tube
V18	OA2	Voltage Regulator Tube
V20	6U8	IF Amplifier
Q1	2N404	Crystal Oscillator
Q2	2N404	Crystal Oscillator
Q3	2N404	Crystal Oscillator
Q4	2N404	Crystal Oscillator
Q5	2N404	Marker Oscillator
Q6	2N404	Marker Oscillator

b. Power Supply, Model PS-21

Circuit Reference Symbol	Type	Function
V101	5V4GA	Rectifier
V102	6AS7G	Series Regulator Tube
V103	12AX7	Amplifier
V104	5651	Voltage Reference Tube
CR601	International Rectifier V 100 HF	High Voltage Selenium Rectifier
CR602	International Rectifier V 100 HF	High Voltage Selenium Rectifier

I-7.2. TUBE COMPLEMENT, MODEL TTG-2.

Circuit Reference Symbol	Type	Function
V101	6AU6	Amplifier, OSC A
V102	6CL6	Cathode Follower, OSC A
V201	6AU6	Amplifier, OSC B
V202	6CL6	Cathode Follower, OSC B
CR401	1N2389	Plug-In Silicon Rectifier
I101	(3S6 (GE))	Stabilizing Lamp, OSC A
I201	(120 V, 3 W)	Stabilizing Lamp, OSC B

I-7.3. TUBE COMPLEMENT, MODEL RF-7a.

Circuit Reference Symbol	Type	Function
V1	6AU6	Buffer Amplifier
V2	6AU6	Frequency Doubler

Circuit Reference Symbol	Type	Function
V3	6AU6	Frequency Doubler
V4	6AH6	Frequency Doubler
V5	OB2	Voltage Regulator
V101	7586	Oscillator
CR1	1N81A	Meter Rectifier
CR2	M 500	B+ Bridge Rectifier
CR3	M 500	B+ Bridge Rectifier
CR4	M 500	B+ Bridge Rectifier
CR5	M 500	B+ Bridge Rectifier
CR6	10A/10LF	Full Wave Heater Rectifier
CR7	10A/10LF	Full Wave Heater Rectifier
CR8	1Z5.8T5	Voltage Regulator

I-7.4. TUBE COMPLEMENT, MODEL PRB-2.

Circuit Reference Symbol	Type	Function
V21	5718	Cathode Follower

I-8. FRONT PANEL CONTROLS

I-8.1. FRONT PANEL CONTROLS, MODEL SB-12bS.

a. INPUT ATTENUATOR. This is a group of six toggle switches which provide attenuations of 1 db, 2 db, 4 db, 8 db, 15 db and 20 db in the SIGNAL INPUT circuit. When the switches are in the down position, the indicated attenuation is inserted.

b. GAIN. The amplitude of the indication on the crt screen is adjusted with this control. Maximum gain is obtained at maximum clockwise position. The GAIN control should be operated at the maximum setting consistent with low noise on the crt display to reduce internal distortion in the Model SB-12bS input circuits.

c. AMPLITUDE SCALE. Selection of linear or logarithmic amplitude presentations is accomplished with this toggle switch. In the LOG position, signals having a 40 db (100:1) amplitude range may be viewed simultaneously on the screen. When using the LOG amplitude range, the horizontal lines on the calibrated screen are used. The calibration range is from 0 db to -40 db in 5 db steps. In the LIN position, signals having an amplitude ratio of 20 db (10:1) may be observed at one time. When using the LIN amplitude range, the calibration dots at the right edge of the calibrated screen are used. This linear scale is divided into 10 equal divisions. It should be noted that because of the time constant factor, the LOG feature does not function properly with narrow pulses.

d. IF ATTEN(uator). This toggle switch allows 20 db of attenuation to be inserted in the i-f amplifier. When this is done, the input signal may be adjusted for full scale LOG deflection. Placing the IF ATTEN(uator) switch in the 0 db position permits the full 60 db dynamic range of the Model SB-12bS to be used. Only the lower 40 db portion is displayed on the crt screen. This switch must always be in the 0 db position when making measurements.

e. CAL(ibrating) OSC(illator) LEVEL. This control varies the output amplitude of the 500 KC crystal oscillator, which is internally connected to the SIGNAL INPUT receptacle. This signal may be used to locate the center frequency of the Panalyzor, and may be modulated by an external audio oscillator or by the built-in 5 KC marker oscillator to provide marker sidebands for setting up any desired sweep width.

The 500 KC signal, in conjunction with the INPUT ATTENUATOR, may be used to check the accuracy of the LOG amplitude scale calibrations (which appear as dots at the left side of the calibrated screen).

In its fully counterclockwise position, the CAL(ibrating) OSC(illator) LEVEL control reduces the oscillator output to zero.

f. CENTER FREQ(uency). This control serves to set or maintain the frequency modulated local oscillator at its specified mean frequency. In this way, the deflection corresponding to a signal at the input center frequency is centered on the crt screen. A concentric vernier control has 10% of the range of the main control.

g. AFC. Operation of this toggle switch to

its upward position turns on the AFC circuit. It reduces the normal 100 KC maximum sweep width to 2 KC. This frequency stabilized narrow scanning width, in conjunction with the 0.1 cps scanning rate, provides the best resolution of which the instrument is capable. The AFC should only be used with sweep rates of 5 cps or less.

h. ILLUMINATION. This control is rotated in a clockwise direction to turn on the power. Continued clockwise rotation of this control increases the edge illumination of the crt screen.

i. BRILLIANCE. The intensity of the screen presentation is adjusted with this control.

j. FOCUS. The sharpness of the screen presentation is adjusted with this control.

k. SWEEP WIDTH SELECTOR. This control provides a choice of five preset sweep widths of 150 cps, 500 cps, 3.5 KC, 7 KC, and 14 KC, and a sixth position marked VAR(iable). In the VAR(iable) position, the sweep width may be set to any value from 0 to 100 KC, the i-f bandwidth may be set for any desired resolution within the capability of the instrument, and the sweep rate may be set to any value from 0.1 cps to 30 cps. The video filter switch is also operative in this position.

In the pre-set positions, the i-f bandwidth is automatically set for optimum resolution. On the two narrowest ranges, the AFC circuit is automatically turned on; on the 3.5 KC, 7 KC and 14 KC ranges it is disabled. On the two narrowest ranges the sweep rate is 0.1 cps, and a low pass video filter with a bandwidth of approximately 40 cps is switched on. The sweep rate on the 3.5 KC, 7 KC and 14 KC ranges is 1 cps, and the video filter bandwidth is approximately 400 cps. The sensitivity of the Panalyzor is constant on all ranges, within ± 15%.

l. FAST SWEEP. This momentary contact lever switch sweep speeds up the sweep rate from 0.1 cps to 1 cps, on the 150 cps and 500 cps preset sweep ranges. This facilitates centering the display on the crt screen without the need to wait 10 seconds between sweeps. It also enables the operator to skip undesired portions of the frequency range being scanned.

m. RF TEST - 5 KC MARKER. This switch turns on either the two transistor crystal oscillators, operating at approximately 3000 KC and 3002 KC, or the 5 KC marker oscillator which modulates the CAL OSC. The 3000 KC and 3002 KC signals, which are turned on when the switch is in the RF TEST position, are internally mixed and connected to the SIGNAL INPUT. An external VFO, (Model RF-7a) tuned to 2500 KC or 3500 KC, must be connected to the VFO INPUT to display the test tones on the crt screen.

With the switch in the 5 KC MARKER position, a transistorized 5 KC oscillator, rich in harmonics, is energized. It is connected to the 500 KC calibrating oscillator and modulates it when the CAL OSC control is operated. The sideband pips at 5 KC intervals are visible out to ± 50 KC from the CAL OSC pip at 500 KC. This display facilitates setting up any desired sweep width in the VAR mode of operation.

The following controls are used relatively infrequently or are only needed when setting up the Panalyzor when using the VAR(iable) position of the SWEEP WIDTH SELECTOR. They are located behind the door to the left of the crt.

n. H(orizontal) POS(ition). This control is used to adjust the position of the baseline trace along the horizontal axis.

o. V(ertical) POS(ition). This control is used to adjust the position of the baseline trace along the vertical axis.

p. SWEEP WIDTH. The scanning width of the instrument is adjusted with this control. When it is turned completely clockwise, the maximum spectrum width for which the instrument is designed, i.e., 100 KC when AFC is off, or 2 KC when AFC is on, can be seen on the screen. As the control is backed off in a counterclockwise direction, the bandwidth viewed becomes narrower. The part that can be seen, however, is expanded across the screen and hence is virtually magnified. The stability required for narrow sweep width and slow sweep rates is provided by turning on the AFC.

The SWEEP WIDTH control, in conjunction with the IF BANDWIDTH control, is useful for separating two or more signal deflections which are so close as to merge into each other.

q. IF BANDWIDTH. Resolution, or the ability to separate individual signals, is dependent upon two factors: The rate of frequency scan and the bandwidth of the i-f section of the instrument. Optimum resolution requires a definite relationship between the two. Resolution sharpens as both the frequency-scanning rate and i-f bandwidth are decreased.

The IF BANDWIDTH control is used to narrow the i-f bandwidth. Counter-clockwise rotation of this control narrows the width of the i-f section. It should be noted that as this control is adjusted, there will be some degree of change in the sensitivity of the equipment.

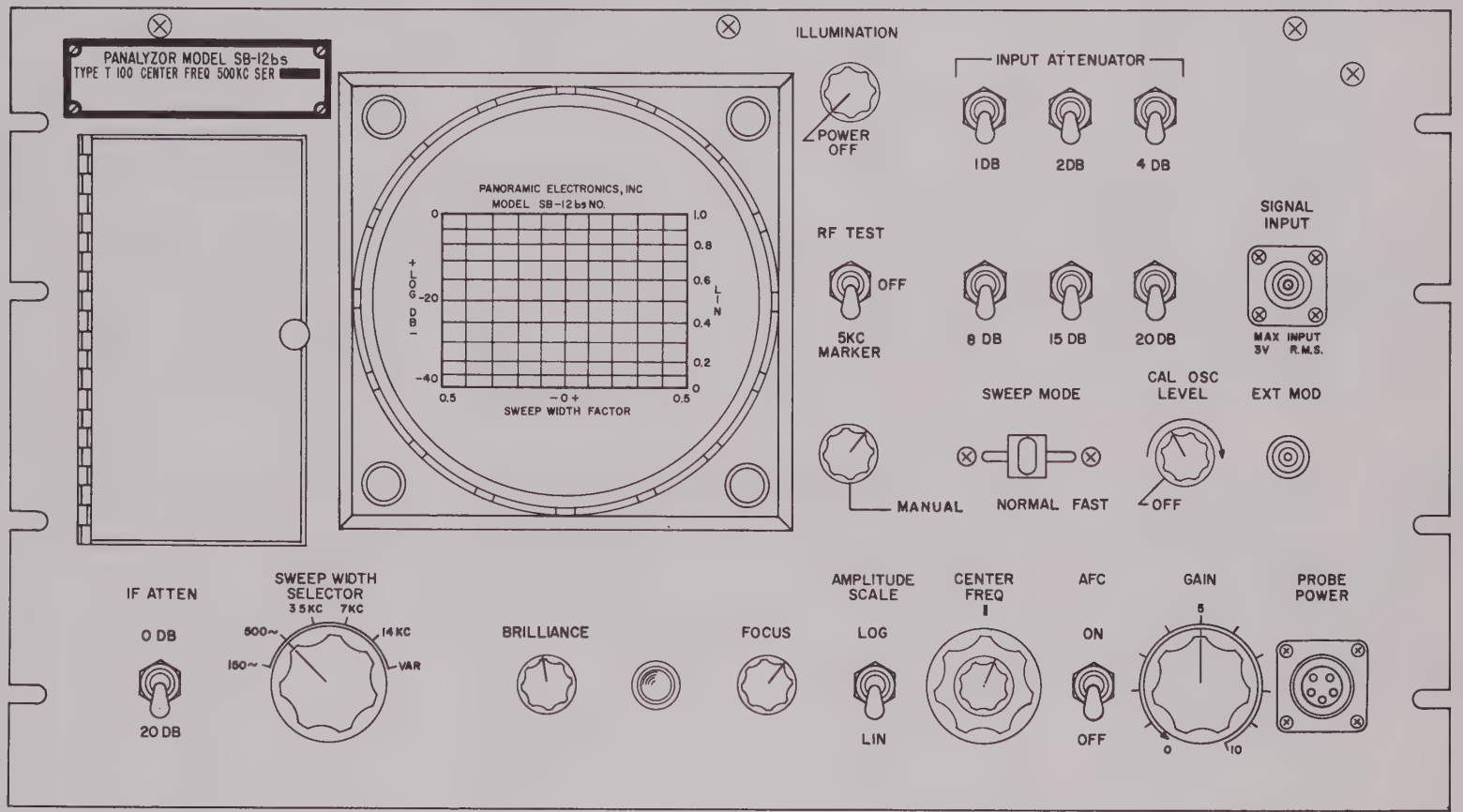


Figure I-3. Front Panel, Model SB-12bS.

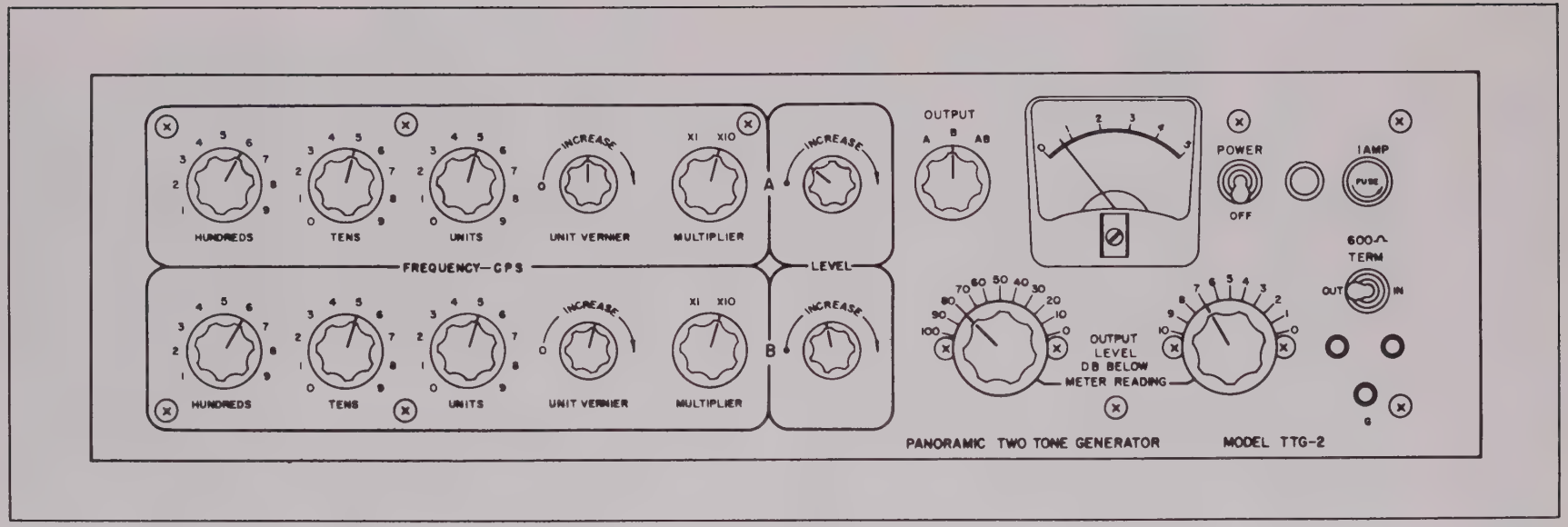


Figure I-4. Front Panel, Model TTG-2.

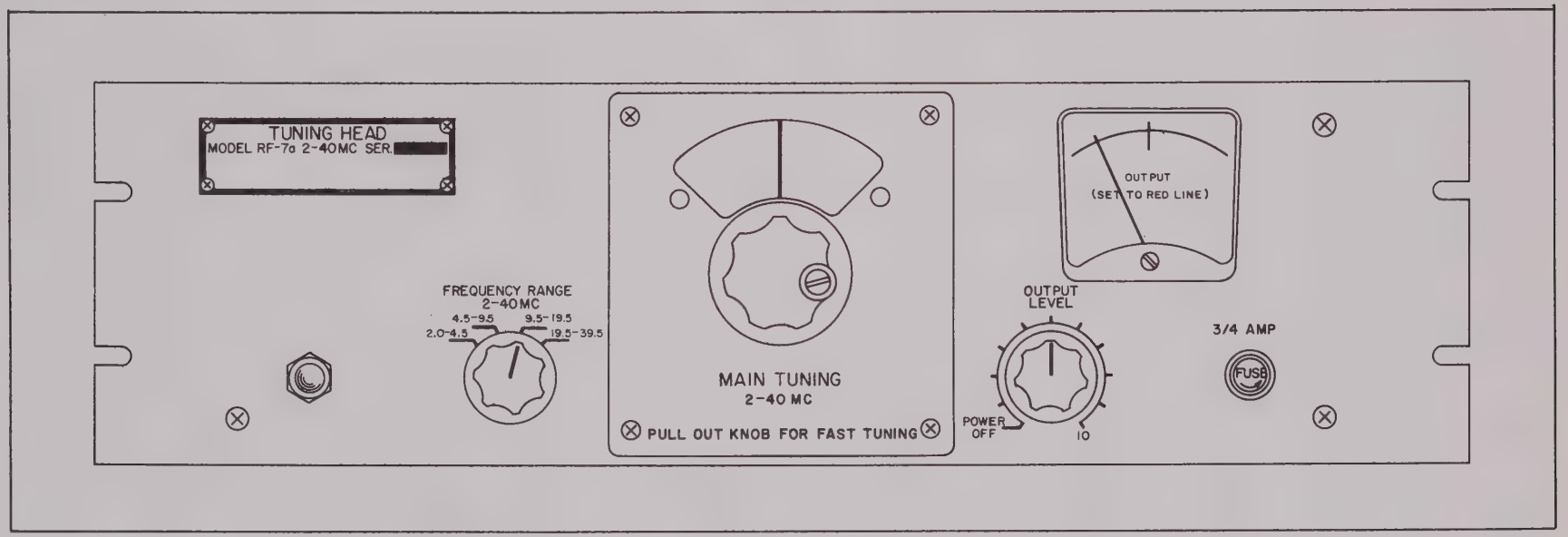


Figure I-5. Front Panel, Model RF-7a.

The frequency-scanning rate is diminished by increasing the scanning period or conversely by decreasing the spectrum width scanned within a given time. The AFC and SWEEP WIDTH controls provide the latter method. For a given setting of the SWEEP WIDTH control there is a complementary setting of the IF BANDWIDTH control to obtain optimum resolution.

On the pre-set sweep ranges the i-f bandwidth is automatically set for optimum resolution.

r. VIDEO FILTER. This toggle switch provides two degrees of video filtering to suppress such unwanted effects as noise, spurious beating between closely adjacent signals, hum, etc.

In the upper (HI) position, the video bandwidth is moderately reduced. In the lower (LO) position of the VIDEO FILTER switch the video bandwidth is greatly reduced. This position is suitable for use with very slow sweep rates and narrow sweep widths.

On the 150 cps and 500 cps pre-set sweep ranges, the LO filter is automatically switched on. On the 3.5 KC, 7 KC and 14 KC ranges, the HI filter is automatically switched on.

s. SWEEP RATE. This control provides continuously adjustable scanning rates between 0.1 cps and 30 cps. Counterclockwise rotation of this control reduces the sweep rate.

The control is operative only in the VAR position of the SWEEP WIDTH SELECTOR.

I-8.2. FRONT PANEL CONTROLS, MODEL TTG-2.

a. FREQUENCY. Each oscillator has three selector switches, marked HUNDREDS, TENS, and UNITS, which select the three significant figures of frequency. The setting of the MULTIPLIER switch, with X1 and X10 positions, determines whether the frequency falls in the decade 100 - 999 cps, or 1000 - 9990 cps.

The UNIT VERNIER control provides a smooth, continuous variation of frequency, sufficient to fill the gaps between the positions of the UNITS switch. The frequency calibration of the switches is valid when the UNIT VERNIER control is set at zero.

b. LEVEL. Each oscillator has a front panel level control, which adjusts its output between the limits of 2 and 4 volts. The level is read on the OUTPUT LEVEL meter.

c. OUTPUT. This is a three position switch which selects the output of either oscillator "A" or oscillator "B", or the mixed output of both oscillators.

d. OUTPUT LEVEL. These are two precision attenuators, providing up to 100 db and 10 db attenuation in steps of 10 db and 1 db respectively. The actual output level in dbm at the terminals of the Model TTG-2 is equal to the algebraic sum of the OUTPUT LEVEL meter reading and the attenuator setting.

e. 600Ω TERM. This toggle switch connects an internal 600 ohm termination resistor across the OUTPUT terminals. This is necessary for correct calibration of the OUTPUT LEVEL attenuators when a high impedance load is used. If the Model TTG-2 is connected to a 600 ohm load, this switch is set to OUT.

f. POWER. This toggle switch turns on the ac power to the Model TTG-2.

I-8.3. FRONT PANEL CONTROLS, MODEL RF-7a.

a. FREQUENCY RANGE. Any one of the four bands provided may be selected with this control. The bands are:

Band 1 - 2.0 - 4.5 MC
Band 2 - 4.5 - 9.5 MC
Band 3 - 9.5 - 19.5 MC
Band 4 - 19.5 - 39.5 MC

b. MAIN TUNING. This control is the main tuning control. The actual range of frequencies available in the rotational range of this control is governed by the setting of the FREQUENCY RANGE switch. In order to provide the required tuning precision, the MAIN TUNING control has been geared down so that approximately 300 turns are required to cover any given band. For rapid scanning, a two-speed mechanical drive is provided. Pulling the tuning knob out, away from the front panel, engages the high speed drive. This provides coverage of a complete band with approximately 30 turns of the MAIN TUNING control.

c. OUTPUT LEVEL. The output level of the Model RF-7a may be adjusted from 0 to greater than 0.3 volts by means of this control. A meter is provided to monitor the output level at all times. The red line on the meter face corresponds to approximately 0.3 volts, which is the recommended operating level.

CHAPTER II
INSTALLATION

II-1. INITIAL INSPECTION

This instrument has been tested and calibrated before shipment. Only minor preparations are required to put the instrument in operation.

If damage to the case is evident when delivery is made, have the person making the delivery describe the damage and sign the notation on all copies of the delivery receipt.

Most public carriers do not recognize claims for concealed damage if such damage is not reported within fifteen days after delivery. All shipping containers should be opened and the equipment inspected before fifteen days elapse.

If damage is found, whether concealed or obvious when delivered, call or write the carrier and ask that an inspection be made by their agent.

Although the carrier is liable for any damage in the shipment, Panoramic Radio Products, Inc. will assist in describing and providing for repair or replacement of damaged items.

The equipment is shipped with all tubes and crystals installed. Check that all such components are properly seated in their sockets.

II-2. INTERCONNECTING PROCEDURE

a. The Panoramic Single Sideband Spectrum Analyzer, Model SSB-3b, is normally operated from a 115 volt, 60 cycle, single phase power source. The power transformer connections are factory wired for 115 volt operation. With Constant-Voltage Transformer T-3003A-1, the equipment will operate properly over a line voltage variation of 95 - 130 volts.

NOTE

THE LINE VOLTAGE REGULATOR SUPPLIED MUST BE USED WITH THE EQUIPMENT TO INSURE PROPER OPERATION. THE REGULATOR IS OF THE SATURABLE REACTOR TYPE AND IS DESIGNED FOR A 60 CYCLE POWER SOURCE. IT SHOULD NOT BE USED ON A 50 CYCLE LINE. 50 CYCLE OPERATION REQUIRES THE USE OF EITHER A SATURABLE REACTOR TYPE REGULATOR SPECIFICALLY DESIGNED FOR THIS FREQUENCY OR A LINE STABILIZER WHICH IS NOT FREQUENCY SENSITIVE. IT SHOULD BE CAPABLE OF A 180 VOLT-AMPERE OUTPUT.

b. Plug the line cord with twist-lock connector on the constant-voltage transformer into the twist-lock a-c receptacle on the PS-21 chassis.

Connect the a-c power line cord from the constant-voltage transformer to J1, the top a-c receptacle of the cabinet junction box, located inside the rear cabinet.

Connect the a-c line cord (W3033) from J4, the bottom a-c receptacle of the cabinet junction box, to a suitable source of a-c power.

c. The Model SSB-3b is normally supplied with all interconnecting cables installed. Make sure that all cables are well seated.

d. Table II-1 lists the normal intercabling of the Model SSB-3b:

e. Installation, High Impedance Probe, Model PRB-2. Connect the 5-contact plug to the PROBE POWER receptacle on the Panalyzor front panel. Connect the Series UHF connector to the SIGNAL INPUT receptacle on the Panalyzor front panel.

As determined by the signal levels involved (see paragraph I-5.4. ELECTRICAL CHARACTERISTICS), the probe is used without attenuator head or with one of the three supplied attenuator heads. The attenuator heads screw on to the cathode-follower section. To indicate attenuation, the attenuator heads are banded. The single-gold-banded head has an attenuation of 20 db. The double-gold-banded head has an attenuation of 40 db. The triple-gold-banded head has an attenuation of 60 db. For convenience, three different test points are supplied. They screw on to the cathode-follower section (when used without attenuator head) or the attenuator head.

The probe test tip is connected to the signal source. Be sure to connect the ground clip of the probe to the ground side of the signal source.

CAUTION

Be sure that the maximum input-signal levels to the probe are not exceeded or harmonics of the input signal will be generated.

TABLE II-1. NORMAL INTERCABLING OF MODEL SSB-3b.

Cable Description	Connections	
	From	To
a-c line cord, integral with TTG-2	TTG-2 rear chassis	J2, cabinet junction box
a-c line cord with twist-lock receptacle and molded-on plug, W4-72	J4, cabinet junction box	Suitable source of a-c power
a-c line cord, integral with RF-7a	RF-7a rear chassis	J3, cabinet junction box
a-c line cord, with twist-lock connector, integral with constant-voltage transformer	Constant-Voltage Transformer	Twist-lock receptacle on on PS-21 chassis
Coaxial cable, with 2 series BNC connectors, 3 ft. long, W13-36	J4, RF-7a rear chassis	VFO INPUT, SB-12bS rear chassis
Interconnecting cable, 14 wire, W74-36	14 pin AN type receptacle on PS-21 chassis	14 pin AN type receptacle on SB-12bS rear chassis
a-c line cord, with molded-on plug, integral with constant-voltage transformer	Constant-Voltage Transformer	J1, cabinet junction box

II-3. INSTALLATION ADJUSTMENTS AND CHECKS

II-3. 1. INSTALLATION ADJUSTMENTS AND CHECKS, MODEL SB-12bS.

a. Rotate the ILLUMINATION control clockwise to turn on the unit. In about a minute the baseline trace should appear on the crt screen.

b. Adjust the BRILLIANCE control until the trace is just discernible. Allow at least a 30 minute warm-up before proceeding with further adjustments and checks.

c. Connect the external signal to the SIGNAL INPUT connector, using the r-f cable supplied. The rear SIGNAL INPUT connector on the analyzer should be used for input frequencies above 20 mc/s. For frequencies below this region, either SIGNAL INPUT connector may be used. The reason for using the rear SIGNAL INPUT is that the cable for the rear panel SIGNAL INPUT jack, which is connected in parallel with the front panel SIGNAL INPUT jack, may cause signal error to be introduced in the attenuator. These signal errors occur where the length of the rear cable becomes a significant fraction of wavelength at frequencies above 20 mc/s.

d. Set the front panel controls as follows:

RF TEST.....OFF
INPUT ATTEN .....All switches UP
GAIN.....Fully counterclockwise
CAL OSC LEVEL....OFF
CENTER FREQ.....Center
AFC.....OFF
AMPLITUDE SCALE..LIN
FOCUS.....For a sharp trace
BRILLIANCE.....As desired
SWEEP WIDTH SEL .VAR
IF ATTEN.....0 DB
VIDEO FILTER.....OFF
SWEEP RATE.....Fully clockwise
IF BANDWIDTH .....Fully clockwise
SWEEP WIDTH.....Fully clockwise
V POS.....So that baseline trace coincides with the frequency scale
H POS.....To approximately center the baseline on the crt screen

e. Turn the CAL OSC LEVEL control fully clockwise. Advance the GAIN control until a pip is displayed at approximately full screen deflection.

f. Rotate the SWEEP WIDTH control counterclockwise until the pip opens up into a horizontal line . Adjust the CENTER

FREQ control for maximum height of the trace. Set the SWEEP WIDTH control fully clockwise. A pip should appear near the center frequency calibration. Adjust the H POS control until the pip coincides with the center frequency calibration.

NOTE

Failure to make the center of the CRT screen adjustment to 500 KC (or 455 KC on units ordered with that input frequency) will cause a signal to go off-screen when sweep width is reduced. In extreme cases it may cause an apparent lack of response flatness when using maximum sweep width.

g. Rotate the SWEEP RATE control through its range. At its clockwise extreme (30 cps) the trace will appear as a line. At its counterclockwise extreme (0.1 cps) a spot should move from right to left on the crt screen with a 10 second period.

h. Turn the SWEEP RATE control fully clockwise. Adjust the SWEEP WIDTH control until the pip base covers approximately one-third of the screen. Turn the IF BANDWIDTH control counterclockwise; the pip width should decrease. At the same time, there may be a change in pip height. It will also be noticed that "ringing" will appear on the trailing edge of the pip. Optimum resolution occurs when the first ringing notch beyond the apex of the pip dips into the baseline (see figure III-3.d.).

i. Turn on the AFC by clockwise rotation of the control. This automatically provides a maximum scanning width of approximately ±1 KC with the necessary center frequency stability. Counterclockwise rotation of the SWEEP WIDTH control reduces the scanning width from ±1 KC to nominally zero. The CENTER FREQ control may be used to center the pip on the screen. The maximum sweep is checked most conveniently by feeding a 1 KC audio signal to the EXT MOD jack. This will generate sidebands which may be set on the end frequency calibrations of the crt screen by means of the SWEEP WIDTH control. Use only sufficient audio amplitude to produce visible and usable sidebands, since excessive amplitude may prevent the crystal oscillator from functioning.

It should be noted that there may be an extraneous pip or pips present on the right side of the screen (but outside the calibrations) when the AFC is on. The SWEEP RATE control should be set for a rate of approximately 5 cps or lower and the IF BANDWIDTH control set appropriately.

j. Set the controls as outlined for CENTER FREQ test. Carefully adjust the GAIN control for full scale deflection of the pip. Switch AMPLITUDE SCALE to LOG. The pip should read -20 DB (center of screen). The LOG calibration appears at the left edge of the screen. Lines are engraved at 5 DB intervals on the screen.

Set IF ATTEN to 20 DB. The pip should now reach the -40 DB calibration.

k. Increase the GAIN and CAL OSC LEVEL controls until full screen deflection is obtained. Operate the INPUT ATTENUATOR switches so as to insert attenuations up to 40 db in 5 db steps. At each setting the pip height should coincide with the corresponding screen calibration within ± 1 db.

l. Set the IF ATTEN to 0 DB and continue to insert attenuation as before until the pip is at the -40 DB calibration. At this point the signal has been reduced 60 db from its original level, which is 20 db over full scale. With all switches down (65 db) the pip should go below the -40 DB calibration point.

m. Set the INPUT ATTENUATOR to zero (all switches up) and adjust the GAIN control for full scale deflection. Switch the VIDEO FILTER to the HI position. This reduces the video bandwidth to about 400 cps. Any noise on the screen should be filtered, and signal pips will be integrated and shifted slightly. The SWEEP RATE should be reduced to prevent excessive distortion of the pip shape. Switch the VIDEO FILTER to the LO position. The video bandwidth is now about 40 cps, and a much greater filtering effect should be observed. This position of the VIDEO FILTER should only be used with sweep rates of the order of 1 cps or less.

n. With a full scale optimally resolved pip (LIN amplitude scale) displayed at the center of the screen, set the SWEEP WIDTH SELECTOR to 3.5 KC. The pip should appear at or near the center of the screen. The amplitude should be essentially unchanged. The sweep width is now ± 1.75 KC, and the sweep rate is 1 cps. The SWEEP WIDTH, SWEEP RATE, IF BANDWIDTH, and VIDEO FILTER controls are not effective on this and the other pre-set sweep width ranges.

o. Set the SWEEP WIDTH SELECTOR to 7 KC. The pip should appear with essentially the same amplitude near the center of the screen. In this position, the sweep width is ±3.5 KC.

p. Set the SWEEP WIDTH SELECTOR to 14 KC. The pip should appear with essentially the same amplitude near the center of the screen. In this position the sweep width is ±7 KC.

q. Set the SWEEP WIDTH SELECTOR to 500 cps. The AFC circuit is automatically switched on for the 500 cycle and 150 cycle sweep widths and the sweep rate is 0.1 cps. The amplitude of the pip should be essentially constant on all ranges. A slight readjustment of the CENTER FREQ control may be needed to center the pip on the screen.

r. See paragraph II-3.3. for RF TEST procedure.

s. To facilitate locating a signal on the ranges employing a 0.1 cps sweep rate, a FAST position has been provided on the sweep mode switch front panel. Moving this switch to the right speeds up the sweep rate to 1 cps, and it immediately returns to 0.1 cps when the switch is released. The pip shape is distorted when the FAST sweep is used, but this does not impair its usefulness for locating signals on narrow sweep widths, or for repeated examination of a portion of the sweep width without requiring a 10 second wait between scans.

t. An external audio signal may be connected to the EXT MOD connector to aid in setting up any desired sweep width. This signal amplitude modulates the CAL OSC.

For example, a 10 KC audio signal will produce sidebands at ±10 KC relative to the center frequency pip. When the SWEEP WIDTH control is adjusted so that these sidebands appear at the left and right extremities of the calibrated screen, the sweep width is ±10 KC or 20 KC overall. Excessive audio amplitude should be avoided, since it may prevent the crystal oscillator from functioning.

u. A built-in 5 KC oscillator is provided to modulate the CAL OSC, in lieu of an external audio signal. It is turned on by setting the RF TEST - 5 KC MARKER switch to the 5 KC MARKER position. Sidebands are produced at 5 KC intervals, of usable amplitude out to ± 50 KC. The frequency accuracy of the 5 KC marker is ± 2%.

v. The H OUTPUT and V OUTPUT connectors on the rear apron of the chassis provide voltages proportional to the horizontal and vertical position of the crt spot. They are intended for operation of a slave oscilloscope or other external indicator.

w. The third contact of the SWEEP MODE switch provides manual scan capability. Use of the MANUAL scan control positions the CRT spot at any desired position on the graticule.

II-3.2. INSTALLATION ADJUSTMENTS AND CHECKS, MODEL TTG-2.

a. Turn the POWER switch to ON. The pilot light should go on at once.

b. Set the front panel controls as follows:

OUTPUT LEVEL	Fully clockwise
LEVEL A	Fully clockwise
FREQUENCY A	As desired
OUTPUT	A
600 Ω TERM	IN

c. The OUTPUT LEVEL meter should read 4 volts.

d. Connect a VTVM to the OUTPUT terminals. Between the balanced (red) output terminals it should read 4 volts. From either terminal to ground (black) it should read 2 volts. Counterclockwise rotation of either OUTPUT LEVEL attenuator should cause a corresponding reduction, in db, in the reading of the VTVM.

e. Repeat the above procedure with OSC B, using a different frequency.

f. Set the OUTPUT selector to AB. The OUTPUT LEVEL meter should read approximately 5 volts.

g. Repeat with both LEVEL controls fully counterclockwise. The individual outputs should be 2 volts, and the combined output 2.5 volts. The outputs from either red terminal to ground should be 1 volt per tone and 1.25 volts for both tones combined.

II-3.3. INSTALLATION ADJUSTMENTS AND CHECKS, MODEL RF-7a.

a. Rotate the OUTPUT LEVEL control clockwise to turn on the unit. It is recommended that the Model RF-7a be allowed to warm up for as long a period as possible, although good frequency stability will be achieved after the first thirty minutes have elapsed.

b. Set the FREQUENCY RANGE Selector to the 2.0 - 4.5 MC range. Set the MAIN TUNING dial to 3.0 MC.

c. Adjust the OUTPUT LEVEL control until the Output Meter pointer is at the red calibration line.

d. Set the SB-12bS CAL OSC control fully clockwise.

e. Set the SB-12bS SWEEP WIDTH SELECTOR to 14 KC, AMPLITUDE SCALE to LOG and adjust the GAIN control and INPUT ATTENUATORS for approximately full scale deflection of the signal on the crt.

f. A pair of sideband pips should appear, symmetrically located about the 500 KC calibrating oscillator signal. These sidebands are the result of heterodyning between the RF-7a output and harmonics of the 500 KC calibrating oscillator signal. Adjust the RF-7a MAIN TUNING dial until the sidebands merge with the calibrating oscillator signal. At this point the dial calibrations of the RF-7a should read 3.0 MC ± 30 KC. The RF-7a calibration may be checked in this manner at each multiple of 500 KC. The calibration accuracy should be ± 1% at all points.

g. The hum modulation level of the RF-7a may be checked by tuning in the 3 MC RF TEST signals available in the SB-12bS. Set the SB-12bS controls as follows:

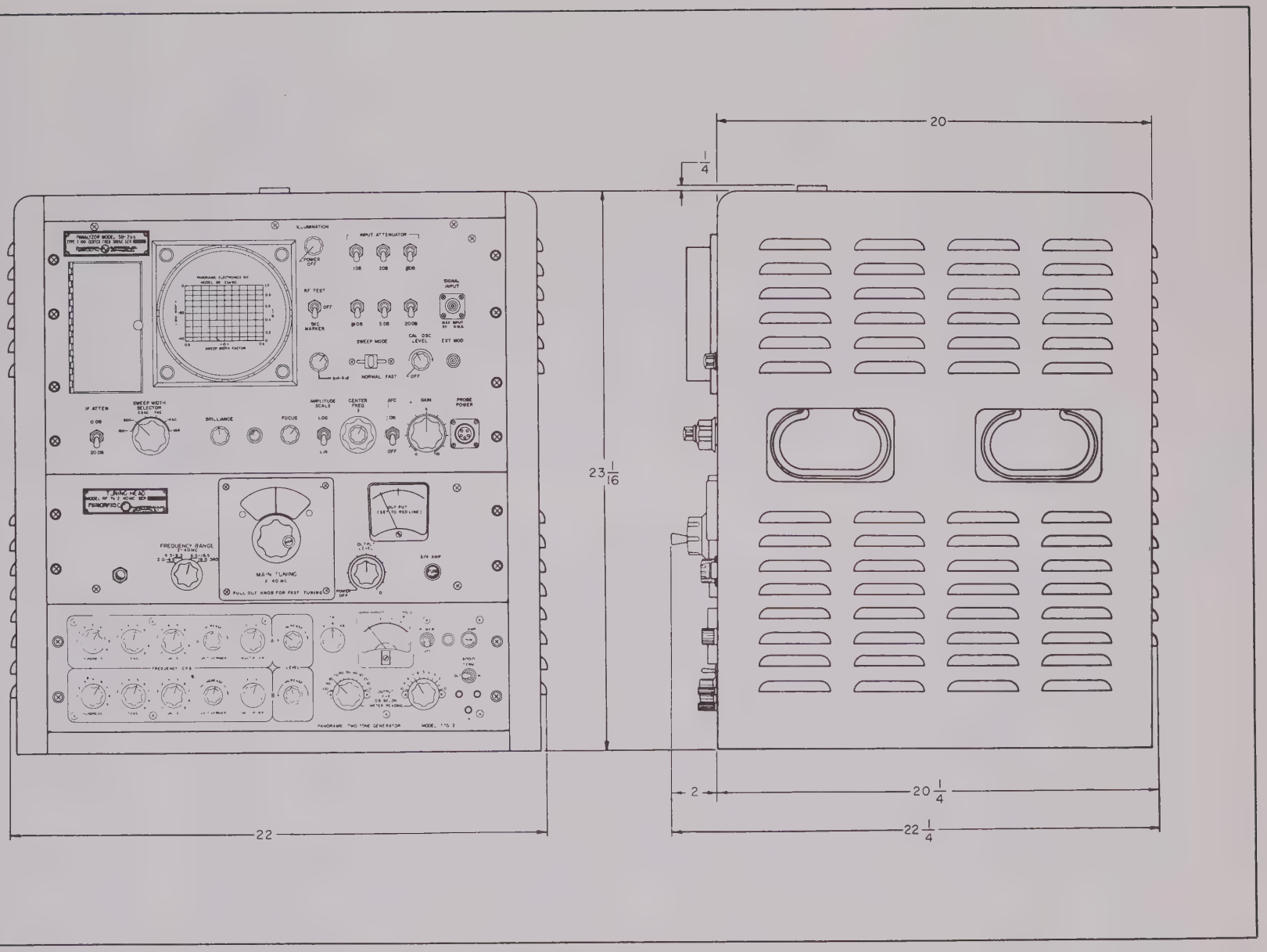


Figure II-1. Outline Dimensional Drawing, Model SSB-3b, in Cabinet.

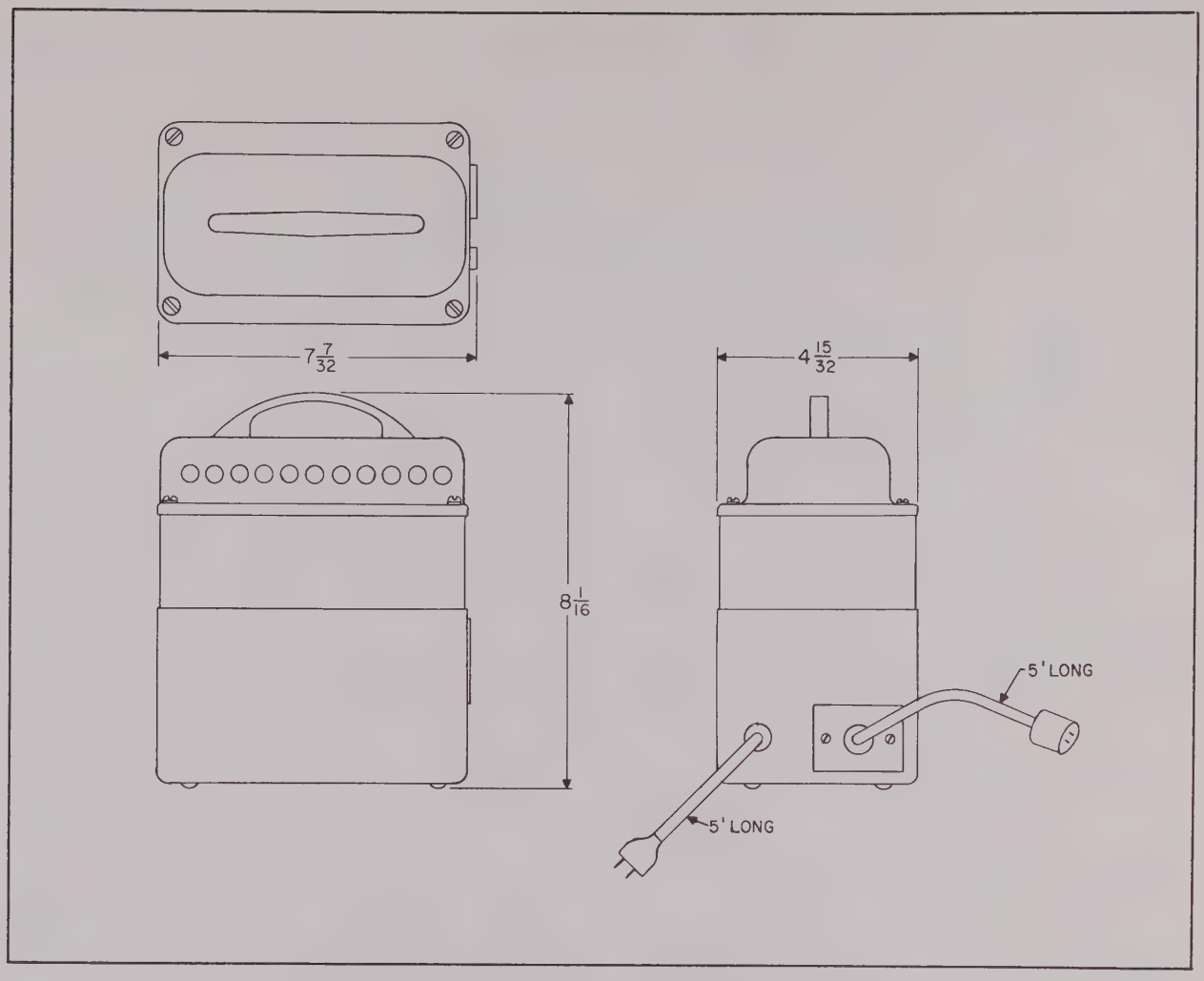


Figure II-2. Outline Dimensional Drawing, Constant-Voltage Transformer T3003A-1.

RF TEST - 5 KC MARKER	RF TEST
INPUT ATTENUATORS	All up
CAL OSC LEVEL	OFF
IF ATTEN	20 DB
SWEEP WIDTH SELECTOR ...	VAR (100 KC)
AMPLITUDE SCALE	LOG
AFC	OFF
CENTER. FREQUENCY.....	To marker
GAIN	Maximum

Tune in the 3 MC test signals with the RF-7a MAIN TUNING control. Center the display on the crt screen. Successively reduce the sweep width to 14 KC and 7 KC, adjusting the RF-7a MAIN TUNING control to center one of the two test tones. Reduce the sweep width to 3.5 KC, 500 cps, and 150 cps, centering the selected test signal as necessary by means of the RF-7a MAIN TUNING control or the SB-12bS CENTER FREQ control.

Adjust the GAIN control for full scale deflection. Set the IF ATTEN on the SB-12bS to 0 db. Any 60 cps hum modulation will be visible as sidebands symmetrically located about the center pip. The amplitude of such modulation should be less than -60 db relative to the pip height. Since the pip is deflected 20 db off scale, this corresponds to the -40 db calibration on the crt screen.

Set the SWEEP WIDTH SELECTOR to 500 cps. At this sweep width, 120 cycle hum sidebands may be checked. These too should be less than -60 db.

h. Set the RF-7a FREQUENCY RANGE switch to 4.5 - 9.5 MC, 9.5 - 19.5 MC, and 19.5 - 39.5 MC. It should be possible to set the OUTPUT LEVEL control on each range for a meter reading of 0.3 volts (red line).

CHAPTER III
OPERATION

III-1. GENERAL OPERATION

a. Turn on the power to the equipment with the SB-12bS ILLUMINATION, RF-7a OUTPUT LEVEL and TTG-2 POWER controls. Allow a one hour warm-up period before operating adjustments are made. When the baseline appears (usually within thirty seconds) set up the front panel controls as follows:

1. Panalyzor, Model SB-12bS.

CENTER FREQ . . . . . On vertical marker
SWEEP WIDTH . . . . . Maximum clockwise
IF BANDWIDTH . . . . . Maximum clockwise
BRILLIANCE . . . . . For desired trace brightness
SWEEP WIDTH SELECTOR . . . . . VAR
FOCUS . . . . . Sharpest trace
AMPLITUDE SCALE . . . LIN
GAIN . . . . . Between half and maximum clockwise
SWEEP RATE . . . . . Maximum clockwise
VIDEO FILTER . . . . . OFF
HORIZONTAL POSITION . For centered position of center-frequency pip
VERTICAL POSITION . . . For baseline coincident with bottom screen calibration
AFC . . . . . OFF
INPUT ATTENUATOR . . All switches up
RF TEST - 5 KC MARKER . . . . . OFF

2. Tuning Head, Model RF-7a.

FREQUENCY RANGE . . . As required
MAIN TUNING . . . . . As required
OUTPUT LEVEL . . . . . 0.3 volts on meter

b. The MAIN TUNING dial of the Tuning Head, Model RF-7a, is calibrated to read signal frequency directly. The actual output frequency of the Model RF-7a is above the test signal frequency by an amount equal to the input center frequency of the Model SB-12bS (500 KC).

In normal operation a pip will move from right (+) to left (-) as the Tuning Head frequency is increased. In this case, the plus and minus signs on the calibrated screen apply; that is signals on the (+) side are higher in frequency while those on the (-) side are lower in frequency.

NOTE

When the output of the Tuning Head is 500 KC below the test signal, an image will be presented on the screen. The image may be identified by the fact that the image will move from left to right as the Tuning Head frequency is increased. The image will appear 1 MC below the frequency calibrated on the MAIN TUNING dial. The Tuning Head should be set to a frequency 500 KC above the test signal except when it is required to measure test signal frequencies in the range of 39.5 MC to 40 MC. This will avoid the presence of image frequencies and spurious resulting from harmonics of the Tuning Head.

c. Slowly search the spectrum with the RF-7a MAIN TUNING dial until the signal of interest appears at the center of the crt screen.

To locate the signal, it may be found convenient to operate the Model SB-12bS at maximum gain. Once the signal is located, the GAIN control may be backed off and the INPUT ATTENUATORs switched in to reduce the signal level to a point where it falls just below full scale.

d. Frequencies of signals appearing on the screen may be determined by adding or subtracting the screen calibration times the sweep width to the frequency to which the Tuning Head is adjusted.

EXAMPLE: The Model SB-12bS is set for maximum sweep width. Each frequency calibration mark is equivalent to a 10 KC separation. A pip appears at +.3. The Tuning Head is set to 2.450 MC.

Freq = RF-7a Indicated Freq ± (Screen Calib x Sweep Width)

Freq = 2.450 MC + (.3 x 100) = 2.480 MC

e. The relative amplitudes of presented signals are proportional to the relative heights of the corresponding deflections, within the limits specified for flatness of response. The use of a preamplifier may affect this flatness.

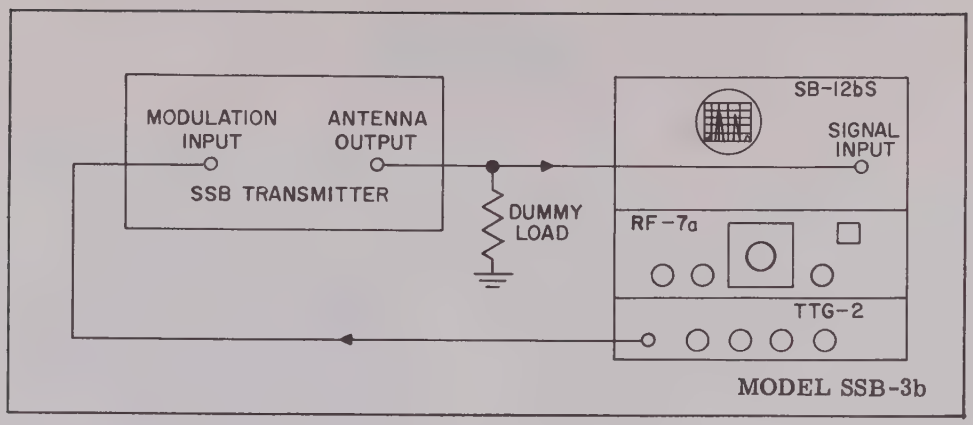


Figure III-1. Block Diagram of Two Tone test.

To observe signals of comparable amplitude (10:1 or less) the AMPLITUDE SCALE switch should be set to LIN. On the other hand, examination of signals widely divergent in amplitude will require the LOG setting of this control. This will allow simultaneous reading of amplitudes having a 40 db range.

g. When it is necessary to avoid loading of the tested device, the High Impedance Probe, Model PRB-2, should be used. The 5 pin power connector on the probe cable is connected to the PROBE POWER receptacle on the Panalyzor front panel. The series UHF plug is connected to the SIGNAL INPUT receptacle on the Panalyzor front panel.

The input impedance of the probe is nominally 12 megohms shunted by 5 uuf. To prevent overload of the probe cathode follower, the INPUT ATTENUATORs and GAIN control of the Panalyzor should be set for the highest usable sensitivity. If high level signals are being analyzed, one of the three screw-on attenuators supplied with the probe should be attached to the probe head. The attenuators provide additional attenuation of 20 db, 40 db, or 60 db (identified by one, two or three stripes on the attenuator shell).

III-2. SINGLE SIDEBAND ANALYSIS

a. The two-tone test, in conjunction with highly selective spectrum analysis, is a sensitive means of rating single sideband transmitter performance.

b. A two-tone test set-up is shown in block form in Figure III-1.

c. Set the front panel controls as follows:

1. Model SB-12bS.

RF TEST . . . . . OFF
INPUT ATTENUATORs . . . . All up
CAL OSC LEVEL . . . . . OFF
IF ATTEN . . . . . 0 DB
SWEEP WIDTH SELECTOR . VAR (100 KC)
AMPLITUDE SCALE, ... LOG
AFC . . . . . OFF
CENTER FREQ . . . . . To marker
GAIN . . . . . Maximum

2. Model TTG-2.

FREQUENCY A . . . . . .7 KC
FREQUENCY B . . . . . 2.5 KC
} Typical frequencies. Any desired combination may be used.

OUTPUT . . . . . AB
OUTPUT LEVEL . . . . . For suitable modulation level of the transmitter

3. Model RF-7a.

FREQUENCY RANGE . . . . . As required
MAIN TUNING . . . . . As required
OUTPUT LEVEL . . . . . Red-line on meter

d. Couple the transmitter output to the Panalyzor front panel SIGNAL INPUT receptacle by suitable means. Signals may be coupled to the Panalyzor capacitively or inductively as required.

CAUTION

An input signal of less than 20 mv is sufficient for all normal measurements. To avoid damage to the equipment, under no circumstances should a signal exceeding 3 volts be coupled to the SIGNAL INPUT connector.

e. Set the Panalyzor SWEEP RANGE SELECTOR to 7 KC or 14 KC. Center the display with the Tuning Head MAIN TUNING dial.

f. Set the IF ATTENUATOR to 20 DB. Adjust the INPUT ATTENUATORs to bring the highest pip on the screen to just over full scale. Adjust the Panalyzor GAIN control to bring the highest pip to full scale on the calibrated screen.

g. Major in-band intermodulation components may now be read in reference to the level of the two tones. The level of the two main tones is considered the 0 DB reference amplitude for comparison over a 40 db range. The calibrations on the left side of the crt screen (0 DB, -20 DB and -40 DB) are read directly in terms of db down.

To examine distortion products from 40 db to 60 db below the signal level, set the IF ATTEN to 0 DB. The upper db portion of the display is now deflected off screen and the -20 db to -60 db portion is displayed. To obtain the correct amplitude of the signals, add 20 db to the indicated reading.

h. Odd order distortion components are distributed symmetrically on either side of the main output signals and are located at separations equal to the frequency difference between them. The distortion components may be readily read as "db down" from the reference levels. Usually the first distortion pips, the third order terms, are the largest. Figure III-2 illustrates a typical two tone test.

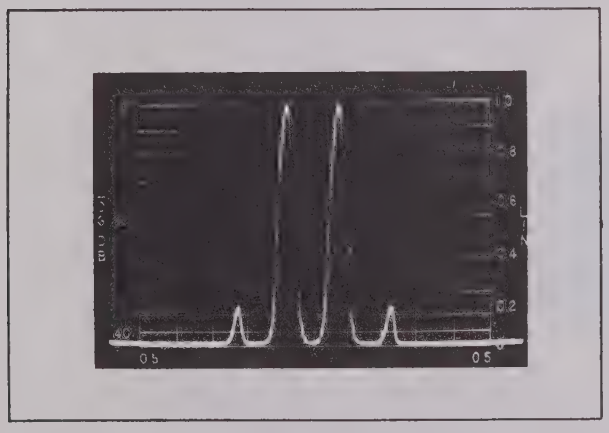


Figure III-2. Two Tone Test.

Fixed sweep width 7 KC. Full scale log sideband tones 0.6 KC and 1.9 KC from carrier (suppressed better than 40 db). Odd order distortion products down 38 db.

See Panoramic Analyzer, Volume 1, No. 3, for discussion of SSB measurements.

For a two tone test, the choice of sweep width usually encompasses three to six times the difference between the modulating frequencies. If the sweep width is too narrow, it may not be possible to display both primary r-f signals and their distortion products on a single sweep. If it is too wide, the "pips" will merge and the distortion products will not be resolved.

i. In general, two r-f tone pips should not intersect at a higher level than that of the distortion products (i.e., -60 db for the full 60 db range of the SSB-3b). If the pips intersect, there may be an increase in the internal distortion of the analyzer. Also, low level sidebands may not be adequately resolved under this condition.

III-3. NARROW BAND ANALYSIS

When signals or a carrier and its sidebands are so closely spaced in frequency that at full sweep width their corresponding deflections tend to merge into each other or mask one another, it may be possible to separate or resolve them by sharpening the i-f bandwidth, and concurrently reducing the scanning width or by reducing the scanning rate or by doing both of the foregoing. The following procedure applies when the SWEEP WIDTH SELECTOR is set to VAR.

a. To obtain better resolution by increasing the scanning time, lower the sweep rate with the SWEEP RATE control. See "c" below for use of AFC.

b. To increase the resolution capabilities by diminishing scanning width, narrowing the i-f bandwidth, and increasing scanning time, use the following procedure.

1. Keep the IF BANDWIDTH control at maximum clockwise (broad).

2. Tune the band of signals of interest to the center of the screen with the Tuning Head controls.

3. Spread the band of signals across the screen by turning the SWEEP WIDTH knob counterclockwise. See "c" below for use of AFC. Note that at reduced scanning width each frequency calibration mark represents a frequency separation equal to one-tenth of the reduced sweep width. Keep the band centered with the CENTER FREQ control.

4. Turn the IF BANDWIDTH control counterclockwise until individual signals are most clearly resolved.

NOTE

Rotation of the IF BANDWIDTH control may result in increased or decreased pip height. Pip amplitude may be returned to suitable level with the GAIN control. Turning the IF BANDWIDTH control counterclockwise after optimum resolution is reached will decrease the resolving power and result in greatly reduced sensitivity.

If the resolution adjustment results in practically complete separation of signal pips maximum resolution can be recognized by the presence of "ringing" on one side of the pip. "Ringing" can be seen more easily with the VIDEO FILTER in the OFF position.

5. To better separate the signals the SWEEP WIDTH and IF BANDWIDTH controls can be further backed off counterclockwise and the SWEEP RATE set to a lower rate. See "c" below for use of AFC.

If it is mandatory to observe a given bandwidth at one time and the signals contained therein are so closely spaced that they cannot be completely resolved, maximum resolution is recognized by the appearance of the clearest picture. Further counterclockwise rotation of the IF BANDWIDTH control will result in lessened resolution and a "bobbing" presentation.

c. For best separation of signals the 0.1 cps scanning rate can be used. Turning AFC on provides a suitably small scanning width (± 1 KC) as well as the frequency stability. The following procedure should be used. AFC may also be used with faster rates, up to approximately 5 cps.

1. With the IF BANDWIDTH control fully clockwise and the SWEEP WIDTH set completely clockwise, tune in the signals to the center of the screen with the Tuning Head MAIN TUNING dial.

2. Turn AFC on. If necessary, adjust the Tuning Head MAIN TUNING dial for a centered presentation. The CENTER FREQ control may be used as an aid to centering the presentation.

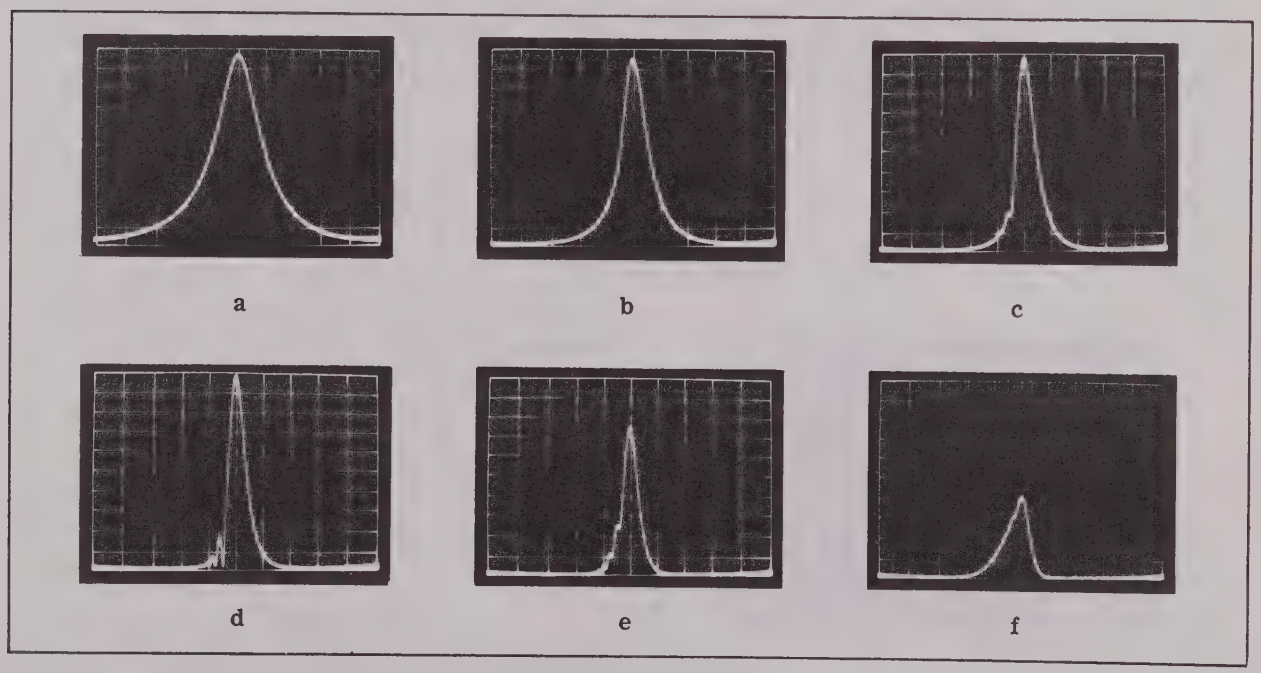


Figure III-3. Ringing as an Indication of Optimum Resolution.

Illustrations (a) to (f) of Figure III-3 indicate progressive variations in pip width effected by counterclockwise rotation of IF BANDWIDTH control. In (a) and (b) i-f width is broad for the particular scanning velocity. (c) shows beginning of "ringing". Extent of "ringing" in (d) shows optimum resolution. As the i-f section is made narrower, excessive "ringing" widens pip and amplitude decreases as shown in (e) and (f).

Further counterclockwise rotation of the IF BANDWIDTH control causes a reduction in amplitude and a tendency of remerging of the pips.

3. Set SWEEP RATE control to a suitable rate, less than 5 cps, depending upon the desired degree of frequency separation and the nature of the signals. AFC should not be used at sweep rates greater than 5 cps. Note that with AFC on and SWEEP WIDTH at maximum clockwise, each frequency-calibration mark on the screen represents 200 cps. Further reduction of sweep width can be had by counterclockwise rotation of the SWEEP WIDTH control.

4. Turn the IF BANDWIDTH control counterclockwise until optimum resolution is obtained. See paragraph b. 4. above.

5. Use the VIDEO FILTER as required to reduce objectionable beating between closely adjacent signals, hum, etc. The HI position provides a moderate amount of filtering. The LO position provides heavy filtering, suitable for use with very low sweep rates. Note that the use of the VIDEO FILTER results in integration of the signal pips as well as slight shifting of the pips.

d. In many cases, it will be most convenient to use the SWEEP WIDTH SELECTOR to set up operating conditions for narrow band analysis. In this mode of operation, the sweep width, sweep rate, i-f bandwidth, and video filtering are automatically set for optimum presentation.

NOTE

When making measurements of low level hum modulation on transmitters, particularly at frequencies over 9.5 MC, a reduction in residual hum in the Model SSB-3b can be effected by turning off the Two-Tone Generator, Model TTG-2.

If such a measurement is made on a single-sideband transmitter, it is recommended that the carrier be re-inserted to the desired level instead of modulating the transmitter with the output of the Model TTG-2.

III-4. OPERATION OF MODEL SB-12bS WITH MODEL RC-3b RECORDER

A connector, J402, located on the rear apron of the analyzer chassis, is provided for operation of the Panalyzor with the accessory chart recorder, Model RC-3b. When the Model RC-3b is not used, the jumper plug, P402, must be installed in J402.

See the Instruction Manual for the Model RC-3b for details of its operation with a Panoramic analyzer. Where reference is made to test frequencies, scan widths and control settings, substitute appropriate values within the operating range of the Model SB-12bS.

The Model SB-12bS may be operated in the VAR mode or any of the pre-set sweep widths. With the SCAN switch of the Model RC-3b in the 10 second position, the SWEEP WIDTH control may be used to adjust the sweep width of the Model SB-12bS to any desired value within its range (when in the VAR mode of operation). All normal operating controls are functional when the Model SB-12bS is used with the Model RC-3b.

It will be found that the IF BANDWIDTH control may be set further counterclockwise (narrower bandwidth) on the 1 minute and longer scans than on the 10 second scan. The proper setting must be determined by successive sweeps through a test signal such as the one from the 500 KC calibrating oscillator in the Model SB-12bS.

When ordering the Model RC-3b separately from the Model SB-12bS, the order should specify that it is to be used with the Model SB-12bS, and the serial number of the Model SB-12bS must be given.

III-5. INTERPRETATION OF SIGNALS

a. A constant carrier signal appears as deflection of fixed height with the nature of presentation depending upon the sweep width as shown in Figure III-4. (a) and (b).

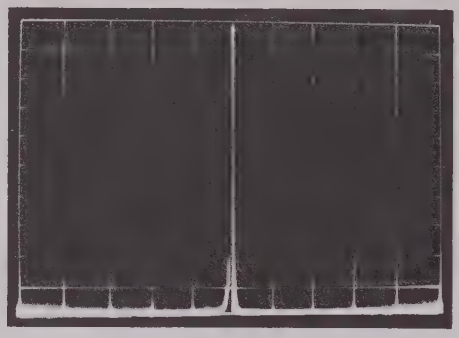
Deviations of the signal from true c-w will result in displays which will indicate the character of the signals as follows:

1. Oscillator Drift-deflection moves slowly across the screen.

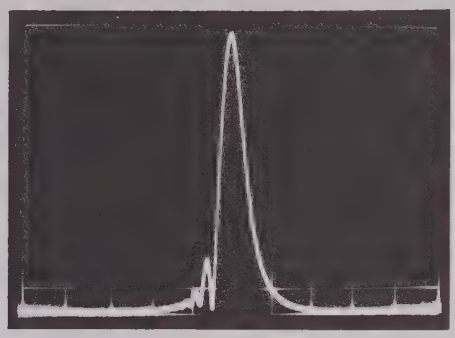
2. Periodic Drift - deflection moves back and forth across the screen.

3. Squegging - interruption of an oscillator at a-f or r-f rate will result in a spectrum display resembling that of a pulse-modulated signal. Side band components will be present in addition to the oscillating frequency.

b. An amplitude-modulated carrier appears as a deflection of variable height. Non-constant tone modulation of low frequency will produce a series of convolutions varying in height, their number being determined by the modulation frequency. The nature of the presentation will depend upon the sweep width, (Figure III-5. (a) and (b).).

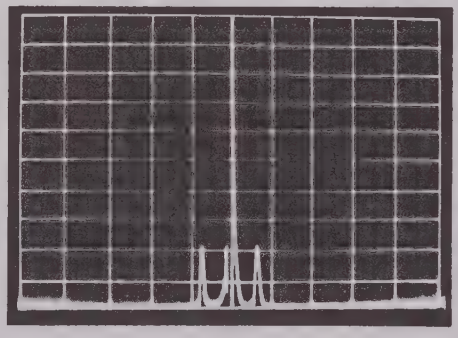


(a) Constant carrier signal at approximately maximum sweep width.

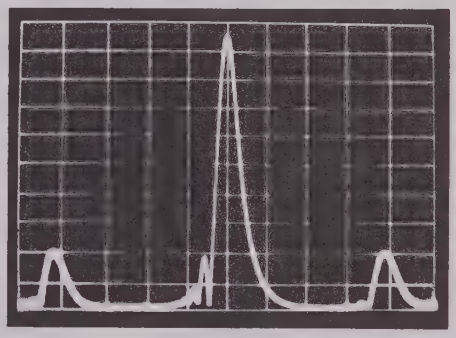


(b) Appearance of constant carrier at reduced sweep width.

Figure III-4. Screen Presentation of Constant Carrier Signal.



(a) A-m signal, showing carrier and two sidebands.



(b) Same a-m signal at reduced sweep width, carrier remains at center of screen.

Figure III-5. Screen Presentations of Amplitude-Modulated Signals.

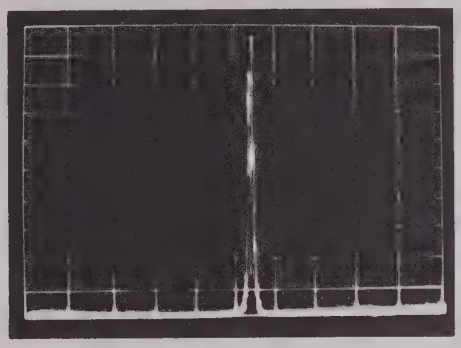
As the modulation frequency increases, the convolutions move toward the two sides of the deflections, and the sidebands become visible. When the modulation frequency is increased, it becomes possible to separate the sidebands by reducing the sweep width of the analyzer. The IF BANDWIDTH control will enable further separation. The higher the frequency of modulation, the farther away those sidebands will move from the center deflections, which represent the carrier. The relative heights of the sidebands may vary as the CENTER FREQUENCY control is turned and as the deflection moves from one end of the screen to the other.

c. The appearance of single sideband signals depends upon the type of modulation employed. Tone-modulated single sideband signals appear as a carrier (for a single tone), or a series of carriers (for multi-tones) of slightly different frequency. Voice or music modulated single sideband signals appear as a "smear" of rapidly varying signals which occupy a finite band width. (See paragraph g., "Signal Interference", below.)

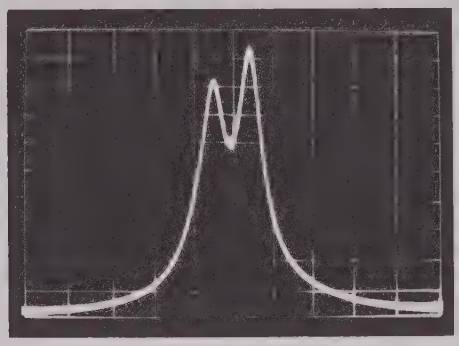
d. A carrier, frequency modulated at a low rate appears as a carrier which wobbles sideways.

e. A CW signal appears and disappears in step with the keying of the signal source. During the moments when the signal is off, the frequency sweep axis is closed at the base of the signal. In very rapidly keyed signals the deflection and the baseline are seen simultaneously.

f. An MCW signal appears like a CW signal of periodical varying height. If the modulation rate is high, sidebands will appear as explained above.

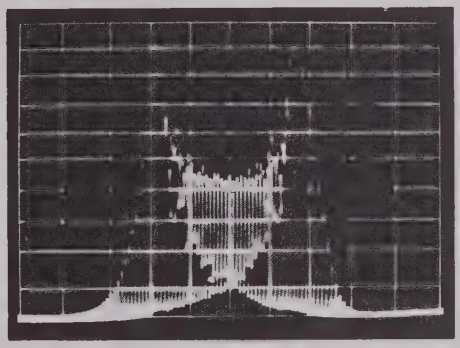


(a) Two interfering signals at maximum sweep width.

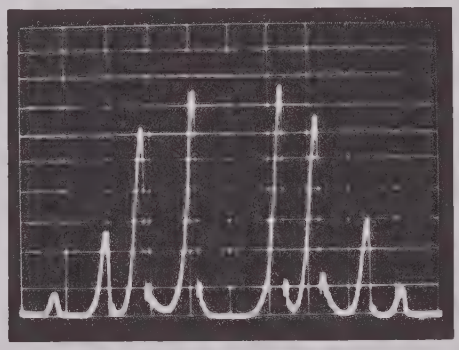


(b) Same signals at reduced sweep width, resulting in improved separation or resolution.

Figure III-6. Resolution of Interfering Signals.



(a) High level frequency-modulation with a low modulating frequency.



(b) Low level frequency-modulation with a high modulating frequency.

Figure III-7. Screen Presentation of Frequency-Modulated Signals.

g. Signal Interference. Two c-w signals which are so close in frequency as to cause aural interference (beats) may appear on the screen as a single signal varying in height as with modulation. As the frequency separation is increased, the signal appears to be modulated on one side only. Further separation will cause a "break" in the apex of the deflection. By reducing the sweep width of the analyzer, the two signals will gradually separate. Further separation is effected with the IF BANDWIDTH control and by setting the SWEEP RATE to a lower rate (Figure III-6. (a) and (b)).

h. Frequency modulated carriers appear as a series of vertical deflections (Figure III-7. (a) and (b).

i. Radio interference signals of various types may appear on the screen of the spectrum analyzer. Such signals may have broad or narrow spectral distributions, and may occur at constant or at random repetition rates. Signals which occur at a variable repetition rate (such as those produced by accelerating motors, vibrators, buzzers, etc.) may move in one direction or the other along the frequency sweep baseline; this is caused by the fact that the analyzer is sweeping at a fixed rate, whereas the observed signal occurs at a variable rate. The images stand still on the screen when there is synchronism between the two. Signals produced by such sources as electrical arcing, switching transients, "static", and other short electrical impulses, have broad spectra which may cover the entire frequency sweep range of the analyzer.

III-6. LOCATION OF SIGNALS ON NARROW SWEEP WIDTHS

The following procedure is recommended for acquisition of signals to be displayed on the 150 cps and 500 cps pre-set sweep widths. Locate the 500 KC CAL OSC signal in the center of the screen with the CENTER FREQ control, on the 3.5 kc sweep width. Turn off the CAL OSC. Using the VAR 100 kc sweep width, at 30 sweeps per second, tune in the signal to be examined with the Model RF-7a and center it on the screen. Turn AFC on. A broad pip, resembling a curved, raised base line, will appear. Some retuning of the Model RF-7a may be required to center this pip on the screen. Switch SWEEP WIDTH SELECTOR to 500 cps. Use FAST SWEEP MODE and retune slightly to place the distorted pip slightly to the left of center of the screen. At normal (0.1 cps) sweep rate the pip should be nearly centered. When it is centered on the 500 cps sweep width, it should remain in view on the 150 cps sweep width.

CHAPTER IV
THEORY OF OPERATION

IV-1. CIRCUIT DESCRIPTION.

IV-1.1. Model SB-12bS

a. Introduction. (See Figure IV-1). As shown in Figure IV-1, the Model SB-12bS consists of the following seven principal sections.

1. Input section.
2. Sweep generator section.
3. Mixer and sweep oscillator, reactance modulator, and AFC section.
4. 100 KC i-f and video section.
5. Crt with horizontal and vertical plate outputs section.
6. Crystal-controlled calibrating oscillator section.
7. PS-21 section.

The input section is provided with three input circuits and a 450- to 550-KC output circuit. Since the output of the first mixer has a pass band of 450 to 550 KC, no RF-7a input frequency is required for incoming signals in the 450- to 550-KC range and an RF-7a input frequency 500-KC higher than the signal input frequency is required for incoming signals outside the 450- to 550-KC range. With a 0.3-volt rms RF-7a input level, a 200UV signal input level will produce full-scale log deflection on the crt screen. This sensitivity is maintained throughout the radio communications spectrum to well above 30 MC. The mixer is usable, at reduced sensitivity, up to 1000 MC, with an external VFO. Dynamic range and attenuator accuracy are reduced above 40 mc.

The sweep generator section is provided with two sawtooth output circuits. The sawtooth rates are variable from 0.1 to 30 cps. One sawtooth voltage wave provides the crt with horizontal sweep. The other sawtooth voltage wave is fed to a reactance modulator whose operations are explained in the following paragraph.

On receiving the sawtooth voltage wave, the reactance modulator in combination with network Z101 causes the local sweep oscillator (part of mixer-oscillator tube V3) frequency to vary in proportion to the progressively varying magnitude of the sawtooth voltage. With the AFC feedback circuit OFF, the scanning width is ±50 KC from the 600-center frequency; with the AFC feedback circuit ON, ±1 KC. In the latter case, AFC provides the frequency stability necessary for the narrow bandwidth. The mixer section of V3 receives two signals: one, those in the 450- to 550-KC output circuit of first r-f amplifier V2, and two, the scanning voltage (nominally 550 to 650 KC) of the local sweep oscillator; the scanning voltage progressively translates each voltage component in the 450- to 550-KC signal to a 100-KC difference frequency signal at the output of the mixer's 100-KC center frequency narrow band output filter.

The 100-KC i-f and video section receives the 100-KC voltages from the output of the second mixer. These voltages, whose magnitudes vary from instant to instant depending upon the composition of the 450- to 550-KC i-f amplifier's signal, are amplified in a narrow band four-stage amplifier, are detected, and are fed to the crt vertical plates via a vertical amplifier.

Consequently, the crt displays the component signals in the 100-KC r-f bandwidth under surveillance. If desired, narrower r-f bandwidths may be displayed across the crt screen. The pip amplitude and position along the calibrated horizontal axis are indicative of each component signal level and frequency, respectively. The sawtooth voltage output of the sweep generator progressively shifts the crt electron beam horizontally across the screen in order to enable the crt to display the successively demodulated 100-KC signals emerging from the second mixer. These signals represent magnitudes of the successive frequency components in the r-f bandwidth being scanned.

If desired, the calibrating oscillator will provide the crt screen with a 500-KC marker. When supplied with an audio signal (fed into EXT MOD jack) the modulated 500-KC signal provides frequency markers with known separations. The built-in 5 KC oscillator, controlled from the front panel of the Model SB-12bS, performs the same function as an external modulating signal, for situations where 5 KC intervals are satisfactory.

The PS-21 is a conventional electronically regulated type supplying +270 volts to the Model SB-12bS.

b. Circuit Description.

1. Input Section. The signal and/or calibrating oscillator input is through a 50-ohm step-type attenuator. Up to 40 db of loss can be inserted in the signal path in 1-db steps. The accuracy of the attenuator is ± 05 db/db up to 30 MC. It is usable with reduced accuracy up to several hundred megacycles.

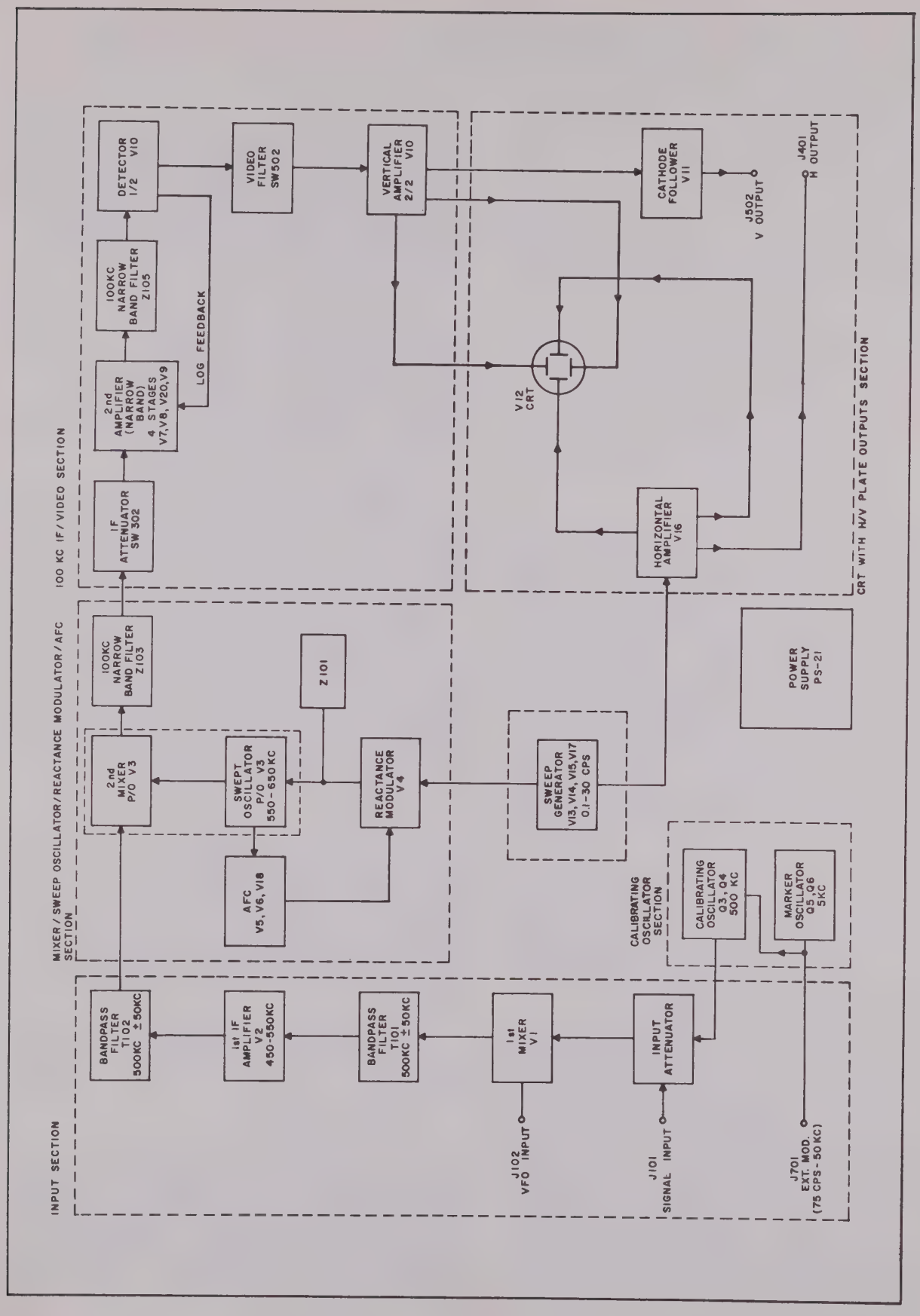

INPUT SECTION
MIXER / SWEEP OSCILLATOR / REACTANCE MODULATOR / AFC SECTION
100 KC IF / VIDEO SECTION
CRT WITH H/V PLATE OUTPUTS SECTION
CALIBRATING OSCILLATOR SECTION
BANDPASS FILTER T102 500KC ± 50KC
1st IF AMPLIFIER V2 450-550KC
BANDPASS FILTER T101 500KC ± 50KC
1st MIXER V1
INPUT ATTENUATOR
J102 VFO INPUT
J101 SIGNAL INPUT
J701 EXT. MOD. (75 CPS - 50 KC)
CALIBRATING OSCILLATOR Q3, Q4 500 KC
MARKER OSCILLATOR Q5, Q6 5KC
2nd MIXER P/O V3
SWEPT OSCILLATOR P/O V3 550 - 650 KC
AFC V5, V6, V18
REACTANCE MODULATOR V4
SWEEP GENERATOR V13, V14, V15, V17 0.1-30 CPS
Z101
100KC NARROW BAND FILTER Z103
IF ATTENUATOR SW 302
2nd AMPLIFIER (NARROW BAND) 4 STAGES V7, V8, V20, V9
100KC NARROW BAND FILTER Z105
DETECTOR 1/2 V10
LOG FEEDBACK
VIDEO FILTER SW502
VERTICAL AMPLIFIER 2/2 V10
V12 CRT
HORIZONTAL AMPLIFIER V16
CATHODE FOLLOWER V11
J502 V OUTPUT
J401 H OUTPUT
POWER SUPPLY PS-21

Figure IV-1. Block Diagram, Model SB-12bS.

The input attenuator is followed by an aperiodic mixer, V1 (6AF4A), which is coupled to neutralized cascode r-f amplifier V2 (6922). A GAIN control potentiometer (R108) in the cathode circuit of V2 allows up to 20 db of attenuation. The output of the r-f amplifier is coupled to second mixer V3 (6BE6). Coupling transformers T101 and T102 in the r-f amplifier are designed to provide a flat bandpass from 450 to 550 KC with a sharp cutoff above 550 KC to reduce image response.

The functions of front panel controls that apply to this section are as follows:

(a). INPUT ATTENUATOR, SW701 through SW706. This is a group of six toggle switches which provide attenuations of 1 DB, 2 DB, 2 DB, 10 DB, 15 DB, and 20 DB in the SIGNAL INPUT circuit. When the switches are in the down position, the indicated attenuation is inserted.

(b). GAIN, R108. The amplitude of the indication on the crt screen is adjusted with this control. Maximum gain is obtained at maximum clockwise position. The GAIN control should be operated at the maximum setting consistent with low noise on the crt display to reduce internal distortion in the Model SB-12bS input circuits.

(c). SIGNAL INPUT, J101. This coaxial jack receives r-f signal to be analyzed. J103 on the rear chassis apron is in parallel with this jack.

(d). VFO INPUT, J104. (REAR CHASSIS APRON INPUT.) VFO is the associated external oscillator or signal generator which is used to heterodyne with the test signal to produce the required frequency to operate the Model SB-12bS. In Model SSB-3b the Model RF-7a Tuning Head is used for this purpose.

NOTE

The heterodyne product should be the difference between the two frequencies used. If the sum frequency is used, spurious screen indications may result from heterodyne products of the test signals and the external signal generator output (including the harmonics).

2. Sweep Generator Section. The sawtooth sweep voltage is derived from a feedback integrator circuit consisting of V13 (6AU6) and V14A (1/2 12AU7). Capacitor C401 is charged with a constant current determined by the setting of SWEEP RATE potentiometers R404 and R407. The resulting sawtooth voltage developed across C401 is available at the cathode of V14.

The setting of SWEEP RATE potentiometers R404 and R407 determines the charging current into C401. As C401 charges negatively, the grid of V13 starts to go negative and greatly amplified positive-going voltage appears at its plate. This is passed through cathode follower V14A (1/2 12AU7) for purposes of impedance transformation. The output of the cathode follower causes the output side of C401 to go positive at a much greater rate than the input side goes negative. During any single sweep, the potential of the input side of C401 (and the grid of V13) remains very nearly zero. Thus, the charging current remains constant and a linear voltage sawtooth is generated.

When the sawtooth voltage reaches a predetermined amplitude, blocking tube oscillator V14B (1/2 12AU7) fires and causes discharge tube V14 (6BH6) to conduct heavily. This tube discharges C401 and the charging cycle repeats itself.

The sawtooth is coupled through LINE SIZE potentiometer control R421 to the grid of horizontal deflection amplifier V16 (12AU7) and to reactance tube V4 (6AH6) through SWEEP WIDTH LIMIT potentiometer control R423 and the sweep width divider network. The second half of V16 (12AU7) acts as a direct coupled phase inverter. The plates of V16 are direct coupled to the horizontal deflection plates of the crt. H POS potentiometer control R427 is in the last stage. FOCUS and BRILLIANCE potentiometer controls R520 and R222, respectively, are in the high-voltage bleeder chain.

The functions of front panel controls that apply to this section are as follows:

(a). SWEEP RATE, R404 and R407. The potentiometer controls provide continuously adjustable scanning rates between 0.1 and 30 cps. Counterclockwise rotation of the controls reduces the sweep rate. The controls are operative only in the VAR position of the SWEEP WIDTH SELECTOR switch.

(b). SWEEP MODE, SW403. This momentary contact lever switch speeds up the sweep rate from 0.1 to 1 cps on the 150-cps and 500-cps preset sweep ranges. This facilitates centering the display on the crt screen without the need to wait 10 seconds between sweeps. It also enables the operator to skip undesired portions of the frequency range being scanned. A third position of the SWEEP MODE switch permits the use of the MANUAL control for manual scan operation.

(c). SWEEP WIDTH SELECTOR, SW402-4B. This switch control provides a choice of five preset widths of 150 cps, 500 cps, 3.5 KC, 7 KC, and 14 KC, and a sixth position marked VAR. In the VAR position, the sweep width may be set to any value from 0 to 100 KC, the i-f

bandwidth may be set for any desired resolution within the capability of the instrument, and the sweep rate may be set to any value from 0.1 to 30 cps. The VIDEO FILTER switch is also operative in this position. In the preset positions, the i-f bandwidth is automatically set for optimum resolution. On the two narrowest ranges, the AFC circuit is automatically turned on; on the 3.5, 7 and 14 KC ranges it is disabled. On the two narrowest ranges, the sweep rate is 0.1 cps, and a low-pass video filter with a bandwidth of approximately 40 cps is switched on. The sweep rate on the 3.5, 7 and 14 KC ranges is 1 cps, and the video filter bandwidth is approximately 400 cps. The sensitivity of the Model SB-12bS is constant on all ranges within ±15 per cent.

(d). SWEEP WIDTH, R424 and R218. The scanning width of the instrument is adjusted with this potentiometer control. When it is turned completely clockwise, the maximum spectrum width for which the instrument is designed (that is, 100 KC when AFC is off, or 2 KC when AFC is on) can be seen on the screen. As the control is backed off in a counterclockwise direction, the bandwidth viewed becomes narrower. The part that can be seen, however, is expanded across the screen and, hence, is virtually magnified. The stability required for narrow sweep width and slow sweep rates is provided by turning on the AFC. The SWEEP WIDTH control, in conjunction with the IF BANDWIDTH control, is useful for separating two or more signal deflections which are so close as to merge into each other.

Chassis-mounted controls that apply to this section are as follows: (These are initially set by factory personnel and should be changed only by qualified technical personnel.)

1. LINE SIZE potentiometer R421.
2. 30-cycle adjust potentiometer R409.
3. 0.1-cycle adjust potentiometer R406.
4. HORIZ OUTPUT jack J401.
5. SWEEP WIDTH LIMIT potentiometer R423.

3. Mixer and Sweep Oscillator, Reactance Modulator, and AFC Section. The functions of a mixer and local oscillator are combined in V3 (6BE6). The center frequency of the oscillator is 600 KC. Reactance stage V4 (6AH6) sweeps the oscillator between 550 and 650 KC in accordance with a sawtooth voltage applied to its grid. Variable resistor R203, CF PAD, varies the screen voltage on the reactance tube and hence tunes the center frequency of the oscillator.

The oscillator output is amplified by V5 (6BH6) and applied to a frequency discriminator V6 (12AL5). The center frequency of the discriminator is 600 KC. It effectively reduces the normal 100-KC sweep width of the local oscillator to 2 KC and stabilizes it against drift. The AFC circuit also reduces hum modulation of the local oscillator by a factor of 50.

Mixer V3 (receiving 450- to 550-KC i-f amplifier V2 signals, and 550- to 650-KC local sweep oscillator V3 signals), equipped with 100-KC center frequency narrow band output filter Z103, delivers variable 100-KC signals to its following stage; these are the result of the scanning local oscillator's frequency-modulated voltages and the component signal voltages in the r-f band under surveillance. In other words, the 100-KC component signal voltages from V3's 100-KC center frequency narrow band output filter Z103 represent, during the scanning cycle, the magnitude/frequency of the voltage components in the output of the 450- to 550-KC i-f amplifier V2.

The functions of front panel controls that apply to this section are as follows:

(a) CENTER FREQ, R206 and R207. Center frequency is the frequency of the signal received on that part of the frequency sweep axis corresponding to zero sweep voltage applied to the reactance modulator.

(b). SWEEP WIDTH SELECTOR, SW402-2T, - 1T, and -3T. This switch control provides a choice of five preset sweep widths of 150 cps, 500 cps, 3.5 KC, 7 KC, and 14 KC, and a sixth position marked VAR. In the VAR position, the sweep width may be set to any value from 0 to 100 KC, the i-f bandwidth may be set for any desired resolution within the capability of the instrument, and the sweep rate may be set to any value from 0.1 to 30 cps. The VIDEO FILTER switch is also operative in this position. In the preset positions, the i-f bandwidth is automatically set for optimum resolution. On the two narrowest ranges, the AFC circuit is automatically turned on; on the 3.5, 7 and 14 KC ranges it is disabled. On the two narrowest ranges, the sweep rate is 0.1 cps, and a low-pass video filter with a bandwidth of approximately 40 cps is switched on. The sweep rate on the 3.5, 7 and 14 KC ranges is 1 cps, and the video filter bandwidth is approximately 400 cps. The sensitivity of the Model SB-12bS is constant on all ranges within ±15 per cent.

(c). SWEEP WIDTH, R424 and R218. The scanning width of the instrument is adjusted with this potentiometer control. When it is turned completely clockwise, the maximum spectrum width for which the instrument is designed (that

is, 100 KC when AFC is off, or 2 KC when AFC is on) can be seen on the screen. As the control is backed off in a counterclockwise direction, the bandwidth viewed becomes narrower. The part that can be seen, however, is expanded across the screen and, hence, is virtually magnified. The stability required for narrow sweep width and slow sweep rates is provided by turning on the AFC. The SWEEP WIDTH control, in conjunction with the IF BANDWIDTH control, is useful for separating two or more signal deflections which are so close as to merge into each other.

4. AFC. This toggle switch places the AFC circuit in operation in its upward position.

Chassis-mounted controls that apply to this section are as follows: (These are initially set by factory personnel and should be changed only by qualified technical personnel.)

1. CF PAD potentiometer R203.
2. SWEEP WIDTH LIMIT/AFC potentiometer R216.
3. AFC TEST jack J201.

5. 100-KC I-f and Video Section. The output of the second mixer is connected through 20-db attenuator SW302 to the 100-KC i-f amplifier. This attenuator is used as a convenient means of setting the signal level at 20 db over full-scale log deflection. The equipment is normally operated with this switch in the 0-db position.

First i-f stage V7 (6U8), a neutralized amplifier, has a crystal filter in its cathode circuit. The filter is operated as a series resonant circuit which couples into the grid of the next stage (pentode section of V7). The grid return to ground is a parallel resonant circuit shunted by a resistance. As the shunting resistance is decreased (by operation of SWEEP WIDTH SELECTOR switch SW402-1B), the effective series resistance of the crystal filter is decreased and the crystal bandwidth narrows.

Second i-f stage V8 (6U8), a neutralized amplifier, is similar to the first. Two shunting potentiometers, R305 and R309, designated IF BANDWIDTH form part of the i-f selectivity circuits. SWEEP WIDTH SELECTOR switch SW402-3B, controls selectivity while switch SW402-2B controls gain.

Third i-f stage V20 (6U8), a neutralized amplifier, is similar to the first. SWEEP WIDTH SELECTOR switch SW402-5B shunts the grid return to ground in this stage.

Fourth i-f stage V9 (6AU6), is a conventional i-f amplifier. A d-c feedback voltage from the following diode detector is applied to the grid of V9 to reduce its gain for strong signals when AMPLITUDE SCALE toggle switch SW301 is in LOG position.

The fourth i-f stage is coupled to diode detector pins 6, 7, and 8 of V10 (12AU7). For LOG amplitude scale indications, the rectified pulses, which appear across the diode load, are fed back through the AMPLITUDE SCALE switch to the grid of the last i-f stage. Chassis-mounted LOG ZERO ADJUST R325 and LOG 20 ADJUST R321 controls determine the magnitude of the feedback voltage and the operating point of the i-f stage which controls the logarithmic characteristic.

The output of the detector is direct coupled to the grid of the second half of V10 (12AU7) through a low-pass R-C filter. Two degrees of filtering and an OFF position are provided by the VIDEO FILTER switch S502.

The plate of the video amplifier is direct coupled to one vertical deflection plate of the crt and to the grid of phase inverter V11 (12AU7) whose output drives the other vertical deflection plate. The variable cathode bleeder resistor of the inverter controls the d-c potential on its associated deflection plate and thus governs vertical position. The second section of V11 (12AU7) is a cathode follower which provides an auxiliary vertical output from J502 on the rear apron of the chassis for driving a slave oscilloscope or other external indicator.

The functions of front panel controls that apply to this section are as follows:

(a). IF ATTEN, SW302. This toggle switch allows 20 db of attenuation to be inserted in the i-f amplifier. When this is done, the input signal may be adjusted for full-scale LOG deflection. Placing the IF ATTEN switch in the 0 DB position permits the full 60-db dynamic range of the Model SB-12bS to be used. Only the lower 40-db portion is displayed on the crt screen. This switch must always be in the 0 DB position when making measurements.

(b). IF BANDWIDTH, R305 and R309. Resolution, or the ability to separate individual signals, is dependent upon two factors: the rate of frequency scan and the bandwidth of the i-f section of the instrument. Optimum resolution requires a definite relationship between the two. Resolution sharpens as both the frequency scanning rate and i-f bandwidth are decreased. The IF BANDWIDTH control is used to narrow the i-f bandwidth. Counterclockwise rotation of this control narrows the width of the i-f section. It should be noted that as this control is adjusted, there will be some degree of change in the sensitivity of the equipment. The frequency scanning rate is diminished by increasing the scanning period or, conversely, by decreasing the spectrum

width scanned within a given time. The AFC and SWEEP WIDTH controls provide the latter method. For a given setting of the SWEEP WIDTH control there is a complementary setting of the IF BANDWIDTH control to obtain optimum resolution. On the preset sweep ranges, the i-f bandwidth is automatically set for optimum resolution.

(c). SWEEP WIDTH SELECTOR, SW402-1B, -2B, -3B, -5B, -4T. This control provides a choice of five preset sweep widths of 150 cps, 500 cps, 3.5 KC, 7 KC, and 14 KC, and a sixth position marked VAR. In the VAR position, the sweep width may be set to any value from 0 to 100 KC, the i-f bandwidth may be set for any desired resolution within the capability of the instrument, and the sweep rate may be set to any value from 0.1 to 30 cps. The VIDEO FILTER switch is also operative in this position. In the preset positions, the i-f bandwidth is automatically set for optimum resolution. On the two narrowest ranges, the AFC circuit is automatically turned on; on the 10- and 30-KC ranges it is disabled. On the two narrowest ranges, the sweep rate is 0.1 cps, and a low-pass video filter with a bandwidth of approximately 40 cps is switched on. The sweep rate on the 3.5, 7 and 14 KC ranges is 1 cps, and the video filter bandwidth is approximately 400 cps. The sensitivity of the Model SB-12bS is constant on all ranges within ± 15 percent.

(d). AMPLITUDE SCALE (LOG-LIN), SW301. Selection of linear or logarithmic amplitude presentations is accomplished with this toggle switch. In the LOG position, signals having a 40-db (100:1) amplitude range may be viewed simultaneously on the screen. When using the LOG amplitude range, the calibration lines on the calibrated screen are used. The calibration range is from 0 db to -40 db in 5-db steps. In the LIN position, signals having an amplitude ratio of 20 db (10:1) may be observed at one time. When using the LIN amplitude range, the calibration dots on the right edge of the calibrated screen are used. This linear scale is divided into 10 equal divisions. It should be noted that because of the time constant factor, the LOG feature does not function properly with narrow pulses.

(e). VIDEO FILTER (HI-LO-OFF), S502. This toggle switch provides two degrees of video filtering to suppress such unwanted effects as noise, spurious beating between closely adjacent signals, hum, etc. In the upper (HI) position, the video bandwidth is moderately reduced. In the lower (LO) position of the VIDEO FILTER switch, the video bandwidth is greatly reduced. This position is suitable for use with very slow sweep rates and narrow sweep widths. On the 150-cps and 500-cps preset sweep ranges, the LO filter is automatically switched on. On the 3.5, 7 and 14 KC ranges, the HI filter is automatically switched on.

Chassis-mounted controls that apply to this section are as follows: (These are initially set by factory personnel and should be changed only by qualified technical personnel.)

1. BANDWIDTH LIMIT potentiometer R310.
2. LOG 20 ADJ potentiometer R321.
3. LOG ZERO ADJ potentiometer R325.
4. Inductors L101A, L101B, and L101C.

6. Crt with Horizontal and Vertical Plate Outputs Section. Cathode-ray tube V12 (5ADP7) has its horizontal and vertical plates driven as follows: horizontal, V16A and V16B; vertical, V10B and V11A. Cathode follower V11 provides monitoring of the crt vertical plates via VERT OUTPUT jack J502.

The crt screen is calibrated by db (line) calibrations ranging from 0 to -40 db (left-hand scale) and by linear (dot) calibrations ranging from 1.0 to 0. A signal with 0 or reference db deflection will drop to 20 db with 20-db insertion in an attenuator. A signal with 1.0 deflection will drop to 0.1 deflection with a 20-db insertion in an attenuator.

The functions of front panel controls that apply to this section are as follows:

(a). FOCUS, R520. The sharpness of the screen presentation is adjusted with control R520.

(b). BRILLIANCE, R522. The intensity of the screen presentation is adjusted with control R522.

(c). H POS, R427. Control R427 is used to adjust the position of the baseline trace along the horizontal axis.

(d). V POS, R507. Control R507 is used to adjust the position of the baseline trace along the vertical axis.

(e). ILLUMINATION, POWER ON-OFF, SW501 and R525. Control R525 is rotated in a clockwise direction to turn on the power. Continued clockwise rotation of this control increases the edge illumination of the crt screen.

Controls not mounted on the front panel that apply to this section are as follows: (These are initially set by factory personnel and should be changed only by qualified technical personnel.)

1. ASTIGMATISM potentiometer R516.

2. VERT OUTPUT jack J502.

7. Crystal-Controlled Calibration Oscillator Section. Transistor Q3 (2N404) is a 500 KC crystal oscillator. It drives an emitter-follower stage, Q4 (2N404) whose output is coupled through a 1000 ohm isolating resistor (R114) to the SIGNAL INPUT of the Model SB-12aS. The output of the calibrating oscillator stages is varied by the CAL OSC LEVEL control R726 which determines the supply voltage delivered to the two transistors.

An external audio signal may be applied, via EXT MOD connector J701, to the emitter of the oscillator transistor Q3. The external audio signal amplitude modulates the 500 KC signal and provides frequency markers with a known separation.

The 5 KC marker oscillator consists of a bridged-T resistance-capacity oscillator with two transistors, Q5 and Q6 (2N404). The frequency of the oscillator is adjustable over a restricted range. It is factory adjusted to 5000 cps ±2%. The output of the oscillator is at a low impedance, and is capacitively coupled to the emitter of the 500 KC crystal oscillator transistor.

The functions of front panel controls that apply to this section are as follows:

(a). CAL OSC LEVEL, R726. This potentiometer control varies the output amplitude of the 500-KC crystal oscillator which is internally connected to the signal input receptacle. The signal may be used to locate the center frequency of the Model SB-12bS and may be modulated by an external audio oscillator to provide marker sidebands for setting up any desired sweep width. The 500-KC signal, in conjunction with the INPUT ATTENUATOR, may be used to check the accuracy of the LOG amplitude scale calibrations. In its fully counterclockwise position, the CAL OSC LEVEL control reduces the oscillator output to zero.

(b). EXT MOD, J701. Provides the crt screen with markers.

Control not mounted on the front panel that applies to this section is as follows: (This is initially set by factory personnel and should be changed only by qualified technical personnel.)

FREQ ADJ, R807. This potentiometer, which is mounted on the oscillator terminal board, is used to adjust the oscillator frequency to 5 KC.

8. R-f Test Oscillators. Two pnp transistors (Q1 and Q2, 2N404) are used in a Pierce type crystal oscillator circuit. The oscillator outputs are resistively added and connected to the SIGNAL INPUT receptacle. The internal third order distortion of the Analyzer, and the hum level of the Tuning Head, may be checked by means of these signals. The signals are at frequencies of approximately 3000 KC and 3002 KC and are essentially free of hum and cross modulation.

The function of the front panel control which applies to this section is as follows:

RF TEST - 5 KC MARKER. This is a three position toggle switch. In the up position the two r-f test tones are applied to the SIGNAL INPUT connector. In the down position the 5 KC marker oscillator signal is applied to the 500-KC calibrating oscillator. In the center position both signals are off.

Controls not mounted on the front panel that apply to this section are as follows: (This control is initially set by factory personnel and should be changed only by qualified technical personnel.)

OUTPUT BALANCE, R727. This control is used to set the two r-f test tones for equal amplitude on the crt screen. It is mounted on the RF TEST terminal board.

9. Power Supply, Model PS-21 or PS-12. The power supply is a conventional electronically regulated type supplying +270 volts to the analyzer.

The high voltage for the crt is obtained from a pair of high voltage selenium rectifiers, CR601, CR602. The bleeder current from the negative crt supply operates a voltage reference tube (V17, 5651) in the analyzer, which supplies -87 volts to the sweep circuits. A voltage regulator tube V18 (OA2) supplies the r-f amplifier and second mixer with +150 volts.

The heaters of V3, V4, V5, and V6, which are in the oscillator and AFC circuits, are operated from a d-c supply obtained from the a-c heater system via a selenium bridge rectifier, CR-1.

The PS-21 is used when the Model SB-12bS is installed as part of the Model SSB-3b.

IV-1.2. Circuit Description, Model TTG-2

a. Oscillators. The oscillators used in the Model TTG-2 are of the bridged-T type. The output of a high gain amplifier (V101, V201,

6AU6) is fed back to its input through two separate paths. One provides positive feedback which is constant with frequency. The other is through a resistance-capacitance network whose transfer characteristic has a rejection "notch" at a frequency:

$$f = \frac{1}{2\pi R \sqrt{C_1 C_2}}$$

At frequencies other than the one defined by the above equation, the negative feedback is greater than the positive feedback and no oscillation can occur. At frequency "f", sufficient attenuation is introduced in the negative feedback path so that the net feedback is positive. The system then oscillates at this frequency, which is determined solely by the values of resistance and capacitance in the bridged-T network.

Only a fraction of the output voltage of the oscillator need be fed back positively to sustain oscillation. The LEVEL control is used to set this feedback voltage, and thereby establishes the level of the oscillator output.

The lamp (I101, I201) in the positive feedback path stabilizes the amplitude of oscillation against changes due to tube characteristics and supply voltages. Its resistance increases with the current through it, thus tending to maintain a constant current in the positive feedback path.

The cathode follower (V102, V202, 6CL6) is used to supply the relatively high current needed in the positive feedback path.

Frequency selection is by means of switched resistors. Various parallel combinations of resistors are used to obtain up to 10 frequencies with 8 pairs of resistors. The resistances in the TENS and UNITS decades are respectively 10 times and 100 times the values used in the HUNDREDS decade. Thus, when shunted across the HUNDREDS decade, they produce frequency changes one-tenth and one-hundredth as great as those produced by the HUNDREDS decade.

The MULTIPLIER switch changes the value of C by a factor of 10 times.

The UNIT VERNIER control shunts one of the capacitive elements of the bridged-T network with a variable capacitor. The range of this adjustment is more than sufficient to allow continuous frequency coverage when used with the frequency selector switches. The frequency calibration of the switches is valid with the UNIT VERNIER control set to zero (maximum capacity).

IV-1.3. Tuning Head, Model RF-7a

a. Introduction. Basically, the Model RF-7a consists of a variable-frequency oscillator covering the tuning range of 2.5 to 5 MC, a buffer amplifier and three doubler stages covering, respectively, the ranges of 2.5 - 5, 5 - 10, 10 - 20 and 20 - 40 MC. The variable-frequency oscillator is inductance tuned, while the buffer and doubler stages are capacitance tuned. All stages are tracked by means of a special gear drive to provide single-dial tuning. The gear drive is designed to provide unusually smooth and precise tuning and, in addition, a high speed drive with a 10:1 increase of tuning rate may be engaged by pulling out the MAIN TUNING knob.

The Model RF-7a includes its own rectifier power supply to provide d-c for both filament and plate requirements. The oscillator employs a nuvistor for minimum hum and microphonics. The oscillator plate voltage is regulated by means of a gas discharge tube and its heater voltage by a Zener diode.

b. Circuit Description.

1. General. The design of the Tuning Head, Model RF-7a, is based upon the use of a highly stable, low noise (including spurious modulation) variable frequency oscillator. For smooth tuning and minimum microphonics, an inductance tuned circuit and a low microphonic nuvistor are employed. Since the oscillator proper can be tuned over a maximum frequency ratio of 2:1, the basic frequency range of the oscillator is 2.5 to 5.0 MC. The oscillator output is then multiplied in successive frequency doubler stages to produce 5 to 10, 10 to 20 and 20 to 40 MC output. Since the SSB-3b input frequency is 0.5 MC, the signal frequency range covered is thus 2.0 to 39.5 MC (or 40.5 MC using low-side injection) and the RF-7a dial is calibrated accordingly in signal frequency, rather than actual RF-7a output frequency.

Since the RF-7a drive shaft requires approximately 11-3/4 turns to cover the 2.5 - 5.0 MC range and the variable capacitor which tunes the buffer and multiplier stages requires approximately 0.44 turns, a gear drive assembly is provided which couples them together for proper tracking. In addition, proper gearing is provided to drive the dial. To provide tuning with maximum smoothness, "slip-wheel" drive is employed (ratio approximately 22:1) between the knob and oscillator shaft. When the limit of oscillator shaft rotation is reached, this drive will slip and prevent damage to both oscillator and tuning condenser.

The MAIN TUNING control is normally geared down so that 300 turns are required to cover each band. Pulling the knob out engages a 10:1 gear drive which allows the band to be covered with only 30 turns of the knob.

Output of the desired frequency range is

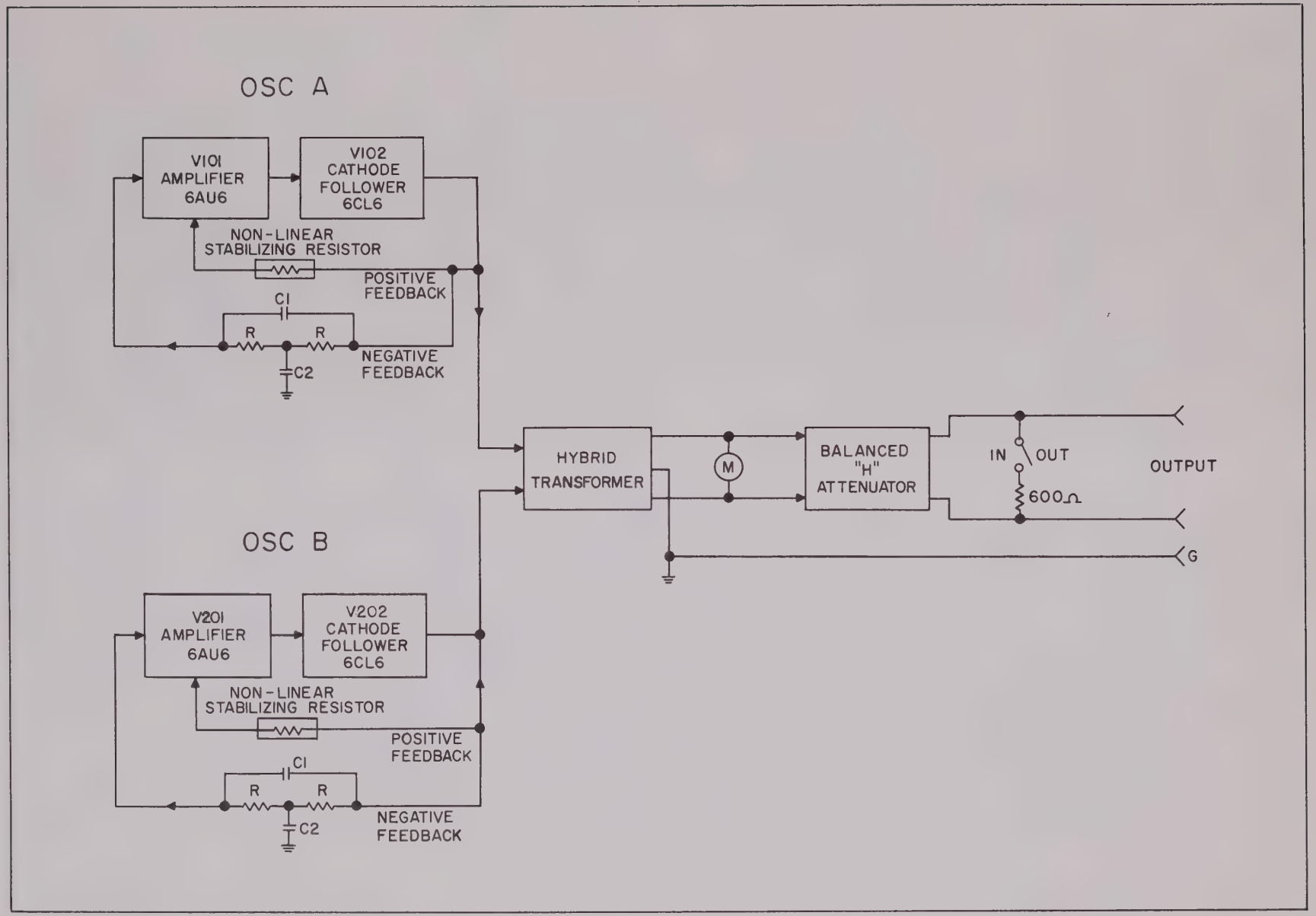


Figure IV-2. Block Diagram, Model TTG-2.

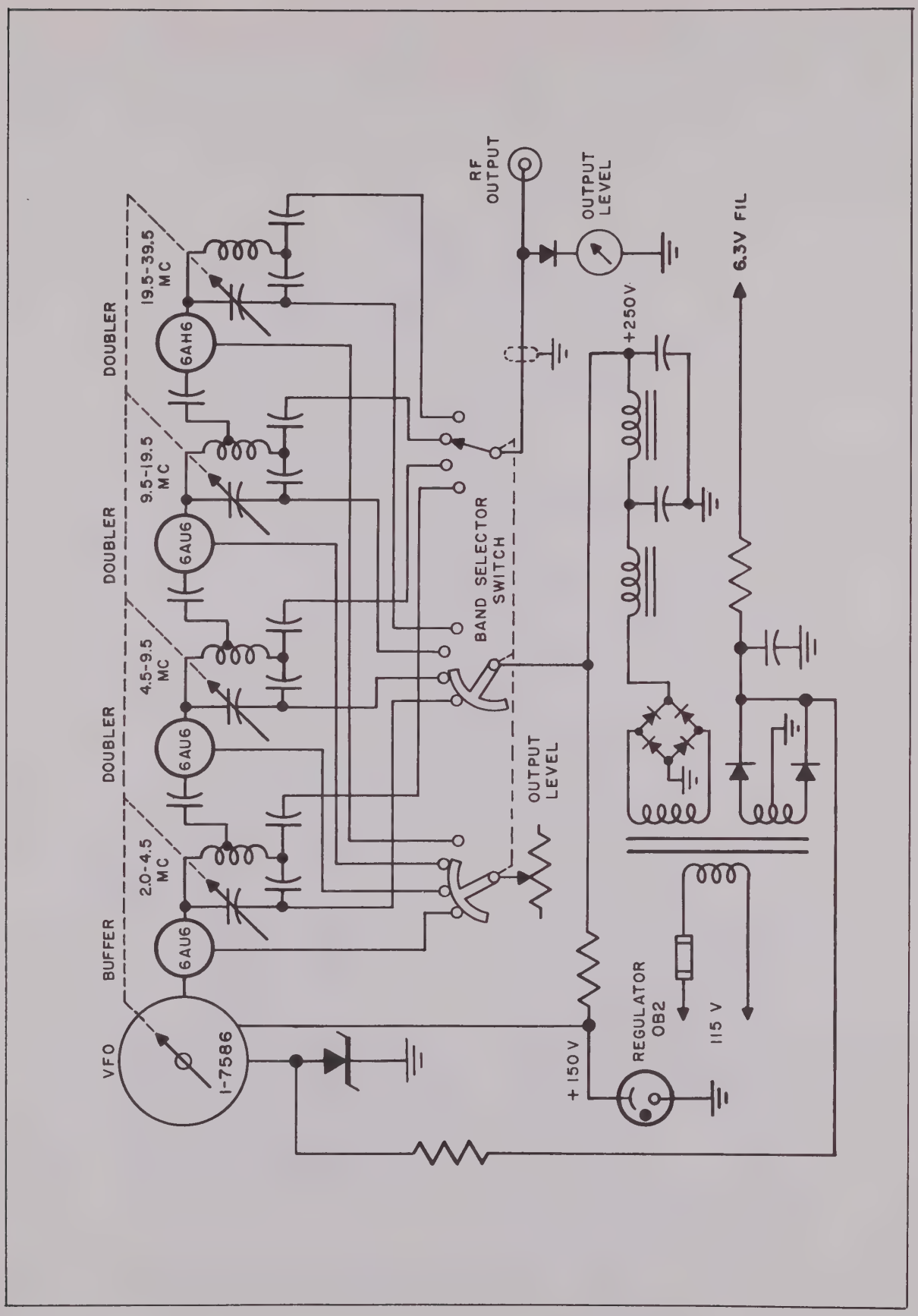


Figure IV-3. Block Diagram, Model RF-7a.

selected by means of the FREQUENCY RANGE switch. This switch provides three internal functions, as follows:

(a). Application of plate voltage to the buffer or multiplier stage supplying the desired frequency range. Voltage is removed from the stages not in use.

(b). Application of screen voltage to the last stage in use via a potentiometer to control the output level, and to all preceding stages at a fixed level.

(c). Switching of the r-f output lead to the tank circuit of the stage in use.

2. Oscillator. The oscillator is a conventional type employing a Type 7586 "Nuvistor" triode. Since the feedback necessary for oscillation is accomplished by means of cathode circuit coupling, the output is taken from the plate of the oscillator to achieve minimum effect of external components upon the oscillator stability. The frequency of oscillation is determined by variable inductance L101 (varied by means of a ferrite core moved axially within the winding), fixed capacitors C3 and C4 and trimmer capacitor C5.

To minimize modulation and the production of unwanted sidebands, the oscillator is rigidly constructed and is contained within heavy aluminum and Mu-metal shields. Stabilized supply voltages (+100 and +6.2) are derived from the power supply as described in paragraph 7 below.

3. Buffer Amplifier. To minimize the effect of changes in load upon the oscillator frequency stability, the oscillator is followed by a tuned buffer stage consisting of pentode V1 (6AU6). The oscillator output is coupled to the grid of this tube by means of a length of shielded lead and a small amount of bias voltage developed via grid resistor R1. Operating voltages are supplied in the conventional manner through plate and screen isolating resistors. The output of V1 is tuned by inductor L1 and variable capacitor C3A (the first section of C3). Output is derived from this "pi-network" tank circuit by connection of the load across capacitor C1. Capacitor C27 is a blocking capacitor to prevent plate voltage from entering the load circuit.

When the FREQUENCY RANGE switch is in the 2.0 to 4.5 MC position, screen voltage is provided for V1 via R5 (OUTPUT LEVEL) to allow variation of the output from approximately 0.1 volt to 0.6 volts, rms.

4. First Doubler. The first doubler stage consists of a 6AU6 (V2) connected in the same manner as V1 except that the plate circuit tunes from 5 to 10 MC. Excitation is supplied by V1 via coupling capacitor C6 and the output is derived across capacitor C10. A tip jack is provided in the grid circuit to read the developed grid voltage for ease in alignment and servicing. With the FREQUENCY RANGE switch in the 4.5 to 9.5 MC position, the OUTPUT LEVEL control is connected to the screen circuit of V2.

5. Second Doubler. Identical to the first doubler, except the tuning range is 10 to 20 MC.

6. Third Doubler. Identical to the first doubler, except for a tuning range of 20 to 40 MC and the use of a 6AH6 tube (V4) to provide greater power output.

7. Power Supply. Plate and heater voltages for all of the operating stages are provided by a rectifier type power supply. The plate power circuit consists of power transformer T1, bridge rectifier CR2 - CR5, filter L6, L7, C22A and C22B and gas regulator tube V5 (OB2). Plate power for all of the stages is taken from the output of the filter except for the oscillator, which is derived from the output of the regulator tube. Regulated dc heater voltage for the oscillator is provided by means of a series resistor and Zener diode to achieve maximum stability and minimum hum.

All heaters in the RF-7a are supplied with d-c voltage provided by full-wave rectifier CR6, CR7 and RC filter R28 and capacitor C24. Both this capacitor and C22 are plug-in types to facilitate maintenance. The power supply is fused by F1 (3/4 amp) and the a-c line is by-passed to prevent power line radiation. A three-wire cord is provided for proper chassis grounding.

8. Output Meter. The output level of the RF-7a is read on a panel mounted meter provided with a center scale index line. When the output level is set to this line, the output voltage is approximately 0.3 volts rms, at full scale the output is approximately twice this value. Voltage to operate the meter is derived from the r-f output line by a rectifier circuit consisting of diode CR1 (1N34A) L5, C21, C34 and R22. The calibration of this meter circuit is within +15% at 0.3 volt, with an error somewhat greater above or below this value.

IV-1.4. High Impedance Probe, Model PRB-2

The cathode follower is a type 5718 triode whose cathode load is the 180 ohm resistance of the Panalyzor input circuit. Plate and heater voltages for the tube are provided through the five-contact plug which is connected to the Panalyzor.

The attenuator heads are simple capacitive divider attenuators.

CHAPTER V

SERVICE AND MAINTENANCE

V-1. GENERAL

This equipment has been thoroughly tested and aligned before shipment, and with normal usage should function as described in the previous chapters. However, as in all electronic devices, occasional failure of a tube or component may result in malfunctioning, necessitating maintenance action. This chapter is divided into eight sections to facilitate its use in the adjustment, alignment, maintenance, and repair of the equipment.

Section 2 describes the procedure for inspecting and replacing components.

Section 3 is a list of the test equipment recommended for use in servicing the equipment.

Section 4 covers the screwdriver-adjust controls found on the chassis of the equipments.

Section 5 describes the touch-up alignment that may become necessary because of aging or failure of a tube or component in the circuit.

Section 6 provides charts showing the tube layouts and the normal voltage and resistance measurements made on properly functioning instruments.

Section 7 is a description of the complete alignment procedure. It is only under the most unusual circumstances that this procedure will have to be used in its entirety. Most of the alignment problems encountered in the field can be solved by using the applicable adjustment techniques mentioned in Section 5.

Section 8 is a list of the replaceable parts used in the equipment.

If the equipment develops trouble which cannot be corrected by using the procedures outlined in this chapter, it is recommended that the instrument be returned to Panoramic Electronics, Inc. for servicing. Before returning the instrument fill out and mail the Repair and Maintenance Form bound in the rear of this Manual. Upon receipt of the information thereon, the company's Service Department will supply the necessary servicing data or shipping instructions. After receiving shipping instructions, forward the instrument prepaid to the factory. If requested, an estimate of charges will be made before the repair is begun.

V-2. INSPECTION AND COMPONENT REPLACEMENT

a. Inspection. All components of the equipment should be given a thorough inspection at regular intervals and whenever maintenance requires removal of an instrument from its cabinet. Moisture may cause deterioration of material and produce substandard operation. Dust and dirt materially affect both electrical and mechanical operation. Keep the various parts clean. Check accessible connections and tubes regularly to make sure that all contacts are clean and tight and that tubes and crystals are held securely in their sockets.

b. Replacement. All tubes and crystals are accessible at the top of the chassis. The pilot lamp is located on the front panel, and is removed by unscrewing. The fuses are located on the front panel of the Power Supply. Spare fuses are mounted on the inside of the equipment.

CAUTION

Never replace a fuse with one of a higher current rating. If a fuse burns out immediately after replacement, do NOT replace it a second time until the cause has been determined and trouble is corrected.

c. Vacuum Tube Replacement. Vacuum tubes should be checked on a reliable tube tester. An indication of "GOOD" on a tube tester does not mean that a tube will necessarily function properly in its circuit, but a "REPLACE", "BAD", or borderline indication does mean that better service will generally result if the tube is replaced. The average commercial tube tester should not be called upon to give more information than this. Many questions regarding the condition of a particular tube in a given circuit can best be answered by substituting a tube known to be free from defects in its place and comparing the performance of the equipment.

V-3. RECOMMENDED TEST EQUIPMENT

Table V-1 lists the equipment (or equivalent) which should be available in order to properly service and align the instruments described in this Manual.

TABLE V-1. RECOMMENDED TEST EQUIPMENT

Nomenclature	Part No. or Model	Application	Range	Accuracy
Standard Signal Generator	Hewlett-Packard Model 606A	Radio-frequency tests	50 KC to 65 MC 0.1 uv to 3 V	Frequency - ±1% Output - ±1 db into 50 ohm resistive load
Audio Oscillator	Hewlett-Packard Model 200CD	Audio-frequency tests	5 cps to 600 KC 0 to 5 V	Frequency ±2%
AC vacuum tube Voltmeter	Hewlett-Packard Model 400D	AC Voltage Measurements	10 cps to 4 MC 0.001 to 3 V	±2% of full scale, 20 cps to 1 MC ±3% of full scale, 20 cps to 2 MC ±5% of full scale, 10 cps to 4 MC

V-4. SCREWDRIVER-ADJUST CONTROLS

These controls are in circuits which seldom require adjustment. They are located on top of the chassis.

V-4.1. SCREWDRIVER-ADJUST CONTROLS, MODEL SB-12bS.

a. Line Size. This control is adjusted for correct baseline length of approximately 1/4" on either side of the frequency scale limits.

b. Sweepwidth Limit. This control is adjusted to provide correct sweep widths in the VAR, 14 KC, 7 KC and 3.5 KC positions of the SWEEP WIDTH SELECTOR.

1. Set the SWEEP WIDTH SELECTOR to VAR.

2. Set the CAL OSC LEVEL control fully clockwise.

3. Adjust the GAIN and CENTER FREQ controls to give an approximately full scale signal centered on the calibrated screen.

4. Connect a 50 KC signal source to the EXT MOD connector. Adjust the amplitude of the 50 KC signal source to give roughly 1/4 scale sideband pips.

5. Adjust the Sweepwidth Limit control to place the sideband pips approximately 1/8 inch inside the left and right extremes of the frequency scale.

6. Set the SWEEP WIDTH SELECTOR to 14 KC.

7. Shift the signal source to 7 KC and check location of sideband pips relative to the right and left extremes of the frequency scale.

8. Switch SWEEP WIDTH SELECTOR to 7 KC.

9. Shift signal source to 3.5 KC and check location of sideband pips relative to the right and left extremes of the frequency scale.

10. Switch SWEEP WIDTH SELECTOR to 3.5 KC.

11. Shift signal source to 1.75 KC and check location of sideband pips relative to the right and left extremes of the frequency scale.

12. In the VAR, 14 KC, 7 KC and 3.5 KC positions of the SWEEP WIDTH SELECTOR, the pips should fall within ±1/2 division of the left and right extremes of the frequency scale. If they do not, adjust the Sweepwidth Limit control slightly to move the pips in the required direction. Repeat steps 6 through 11 above until the sideband pips fall within ± 1/2 division of the left and right extremes of the frequency scale in the VAR, 14 KC, 7 KC and 3.5 KC positions of the SWEEP WIDTH SELECTOR.

c. Sweepwidth Limit AFC. When the sweep width has been adjusted in accordance with paragraph V-4.1.b. above, set the SWEEP WIDTH SELECTOR to 500 cps and modulate the CAL OSC with a 250 cps signal. Adjust the Sweepwidth Limit AFC control to place the sidebands on the left and right extremes of the frequency scale. This also calibrates the 150 cycle sweep range.

d. Astigmatism. This control is adjusted, together with the FOCUS control, to produce a sharp circular spot on the crt.

e.

1. IF GAIN. This control is effective in the VAR position of the SWEEP WIDTH SELECTOR. It adjusts the gain of the i-f amplifier for the specified sensitivity.

(a). Set the front panel controls as follows:

IF ATTEN	20 DB
SWEEP WIDTH SELECTOR	VAR
AMPLITUDE SCALE	LIN
CENTER FREQ	Marker
AFC	OFF
GAIN	10 (maximum)
CAL OSC LEVEL	OFF
INPUT ATTENUATORS	All up
H POS	Normal Operation
V POS	Normal Operation
SWEEP WIDTH	Maximum (clockwise)
IF BANDWIDTH	Maximum (clockwise)
VIDEO FILTER	OFF
SWEEP RATE	Maximum (clockwise)
RF TEST - 5 KC MARKER	OFF
RF-7a FREQUENCY RANGE	2.0 - 4.5
RF-7a MAIN TUNING	3 MC
RF-7a OUTPUT LEVEL	to red line meter indication

(b). Connect a 3 MC signal source to the front panel SIGNAL INPUT connector. Set the amplitude of the signal source to 1 mv.

(c). Adjust the IF GAIN control for a full scale pip on the screen.

2. 14 KC. This control adjusts the i-f gain in the 14 KC position of the SWEEP WIDTH SELECTOR. It is set for the same overall gain obtained in paragraph e.1.

3. 7 KC, 3.5 KC, 500 Cps and 150 Cps. These i-f gain controls are adjusted in a manner similar to the adjustment of the 14 KC IF Gain control.

f. Log Zero Adj and Log 20 Adj. These controls may require adjustment if the last i-f tube (V9, 6AU6), the detector (V10, 12AU7) or the crt (V12, 5ADP7) is replaced.

1. Set the baseline trace accurately on the calibrated line with the V POS control.

2. Set the INPUT ATTENUATOR to 20 DB and AMPLITUDE SCALE to LIN. Adjust the CAL OSC LEVEL control to obtain a full scale deflection on the crt.

3. Set AMPLITUDE SCALE to LOG and the INPUT ATTENUATOR to 0 DB. Adjust the Log Zero Adjust control until the pip reaches the 0 DB screen calibration.

4. Set the INPUT ATTENUATOR to 20 DB and adjust Log 20 Adjust until the pip reaches to the -20 DB calibration line on the screen.

5. Set the INPUT ATTENUATOR to 0 DB and readjust Log Zero Adjust, if necessary.

6. Since the Log Zero Adjust and Log 20 Adjust controls interact to some extent, it may be necessary to repeat the foregoing procedure several times to obtain proper calibration of the LOG scale.

7. Check the intermediate points of the LOG calibration using the INPUT ATTENUATOR. If the error at any point exceeds ±1 db, it may be possible to readjust the log scale calibration controls so that the error remains within these limits over the entire 40 db range. If this cannot be done, it is suggested that different tubes be tried in the V9 and V10 circuits. If this does not achieve proper calibration the screen must be recalibrated.

NOTE

This check should be performed with the IF ATTEN in the 20 DB position to reduce noise on the baseline. Set the GAIN control fully clockwise and the CAL OSC LEVEL for a full scale (LOG) pip when all INPUT ATTENUATORS are up. The full 40 db calibrated screen may be checked using the INPUT ATTENUATORS alone.

g. .1~ Adj and 30~ Adj Sweep Rate Adjustment.

1. Set the SWEEP WIDTH SELECTOR to 500 cps. Adjust .1~ Adj control until the period of the horizontal spot motion is 0.1 cps.

2. Set the SWEEP WIDTH SELECTOR to VAR and the SWEEP RATE control fully clockwise. Modulate the calibrating oscillator with a 60 cps signal and turn the SWEEP WIDTH control fully counterclockwise. Adjust CENTER FREQ

control until the baseline rises and a sine wave display can be seen on the crt. Adjust 30~Adj control until two cycles of the sine wave appear on the screen.

3. Repeat the procedure given in g. 1. above. There is some interaction between the .1~ Adj and 30~ Adj controls, and it may be necessary to repeat the entire procedure several times.

h. CF Pad. Set the CENTER FREQ control to its center position. With the SWEEP WIDTH SELECTOR at VAR, set the SWEEP RATE and IF BANDWIDTH controls fully clockwise and the SWEEP WIDTH control fully counterclockwise. Adjust the CF PAD until the baseline rises to a maximum reading (the CAL OSC LEVEL and GAIN controls should be set for an on-screen crt deflection near full scale).

Return SWEEP WIDTH to its maximum clockwise position. Adjust H POS to make the pip coincide with the center frequency scale calibration.

i. Voltage Regulator Adjust. This control (located on the power supply chassis) is adjusted to give +270 volts dc at the pin jack on the rear apron of the power supply chassis.

V-4.2. SCREWDRIVER-ADJUST CONTROLS, MODEL TTG-2.

Five screwdriver-adjust controls are located on the rear of the chassis. These controls are not used in the course of normal operation. The functions of these controls are as follows:

a. Oscillator A Level Limit Adjustments. The two screwdriver-adjust controls, MIN LEVEL A and MAX LEVEL A, are used to set the range of adjustment of the front panel LEVEL control. They are normally set for limits of 2 and 4 volts, but may be adjusted for any desired range within these limits. The MIN LEVEL adjustment is set with LEVEL fully counterclockwise, and the MAX LEVEL is set with LEVEL fully clockwise. Since there is some interaction between these adjustments, the procedure may have to be repeated until the desired limits have been reached.

b. Oscillator B Level Limit Adjustments. These correspond to the adjustments for Oscillator A.

c. Hybrid Balance. This adjustment balances the hybrid transformer for minimum interaction between oscillators.

Readjustment of this control will not normally be required in the field. Should it be necessary to do so, set each oscillator to deliver the same output at some high frequency, such as 7 kc and 9 kc. Using a selective wave analyzer, observe the amplitude of each signal when the output selection is switched to AB. If the amplitudes change, adjust HYBRID BALANCE until no change in component amplitude occurs when the two signals are combined. An alternative method is to use a true RMS voltmeter, which should show a 3 db increase when the two equal amplitude signals are combined.

d. Distortion Adjustments. The screen voltage of each oscillator tube (V101, V201) is adjustable for minimum harmonic distortion. The adjustment is made for each channel individually, using the A Distortion and B Distortion controls on the rear of the chassis. A suitable distortion meter or spectrum analyzer should be used to monitor the second and third harmonics while making this adjustment.

V-4.3. SCREWDRIVER-ADJUST CONTROLS, MODEL RF-7a.

R28. This adjustable wirewound resistor is located under the chassis, near the heater supply full wave rectifiers. It is used to adjust the output of the dc heater supply to 6.3 volts.

V-5. TROUBLESHOOTING AND TOUCH-UP ALIGNMENT

V-5.1. TOUCH-UP ALIGNMENT, MODEL SB-12bS.

The Model SSB-3b was factory aligned and quality controlled before shipment, and should not require realignment under normal conditions. However, it should be noted that the alignment was performed with the original set of tubes in operation. When tubes are replaced, touch-up alignment may become necessary due to the non-uniformity in operating characteristics of vacuum tubes.

Table V-2 indicates adjustments which may be required when tubes age or are changed. The table indicates general areas to be checked. It is not intended to imply that any or all of the adjustments will have to be made.

TABLE V-2. TOUCH-UP ALIGNMENT, MODEL SB-12bS.

TUBE	ADJUSTMENTS
V1	Selected replacement tube, Replacement should provide third order distortion of less than 60 db and direct sensitivity (at 500 KC) at least half as as great as conversion sensitivity. IF Gain controls.
V2	None
V3	CF PAD, Sweepwidth Limit controls. See paragraphs V-4.1.b. and h.

TUBE	ADJUSTMENTS
V4	Z101, CF PAD, Sweepwidth Limit control. See paragraphs V-4.1.b. and h. and V-7.1.c.
V5	None
V6	None
V7	IF Gain controls. See paragraph V- 4.1.e.
V8	IF Gain controls. See paragraph V-4.1.e.
V9	Log Zero, Log 20 controls. See paragraph V-4.1.e.
V10	Log Zero, Log 20 controls. See paragraph V-4.1.e.
V11	None
V12	Line Size, Log 20, Log Zero and Sweepwidth Limit controls. See paragraphs V-4.1.a. b. f.
V13	None
V14	None
V15	Selected replacement tube. Replacement should be selected for best linearity.
V16	None
V17	None
V18	None
V19	None
V20	IF Gain controls. See paragraph V-4.1.e.
V101	None
V102	None
V103	None
V104	Voltage Regulator Adjust.

V-5.2. TROUBLESHOOTING, MODEL TTG-2.

Table V-3 is a guide to troubleshooting the Model TTG-2. The principal types of trouble which may be encountered are listed. For each trouble, appropriate procedures are indicated.

TABLE V-3. TROUBLESHOOTING, MODEL TTG-2

Symptom	Procedure
No output from one oscillator	Check stabilizing lamps, I101 and I201 (interchange the two lamps). Check setting of MIN LEVEL control (screwdriver adjustment).
No output from either oscillator	Check power supply voltages.
Excessive hum	Replace C401.
Excessive harmonic distortion from one oscillator	Replace 6CL6 (V102 or V202). Readjust screen voltage of V101 or V201.
Excessive intermodulation distortion	Check hybrid balance adjustment.

CAUTION

Always turn power off before removing any tubes. Never operate this equipment without all tubes in their sockets. Damage to tubes may result from failure to observe this precaution.

V-5.3. TROUBLESHOOTING, MODEL RF-7a.

Since the Model RF-7a is not a complicated device, its operation may be checked initially by using only the meter provided on the instrument itself. Ordinarily no preventive maintenance will be required, other than tube replacement, except as noted below.

a. Lubrication. All important bearing points of the gear drive assembly have been provided with "Oilite" porous bronze bearings which hold sufficient oil for almost indefinite usage. However, it may be necessary, after several years' hard usage, to replenish these bearings. Use SAE 10 grade oil. One drop on each bearing should be sufficient. To lubricate the knob shaft bearings, remove the knob and dial cover, thus exposing the bearings located within the dial gear.

The main points in the oscillator assembly itself which may eventually require lubrication are the lead screw and the thrust bearing (internal). The recommended lubrication for the stop-washers is Molybdenum disulphide (Alpha Molykote M77 or equal) applied lightly with a toothpick. The stop-washers and ball bearing should never require lubrication.

NOTE

If removal of the oscillator from the chassis for lubrication is considered necessary, refer to paragraph V-7.3.c. for recommended procedure.

b. The Model RF-7a, as originally shipped, will deliver an output considerably in excess of 0.3 volts on all bands. Therefore, as long as this condition exists, it may safely be assumed that the unit is functioning normally and that maintenance is not required. However, should the output fall below this value, the trouble will generally fall into one of three broad categories, as follows:

1. No output on any band. Probably due to rectifier failure, oscillator failure or blown fuse, in that order.

2. Gradually diminishing output over long period of time. If observed in 2.0 - 4.5 MC position, probably weak buffer tube.

3. Low or no output in bands above 2.0 - 4.5 can be isolated by noting the position of the bandswitch in which it first occurs. Replace the tube associated with that position or the one preceding.

CAUTION

When changing tubes do not remove more than one at a time without turning the power off. The poor regulation of the heater supply will cause the voltage to rise to a value which, if sustained, might damage the remaining tubes.

It will be helpful to check the voltages derived in jacks J1, J2 and J3 against the values given in Table V-4 if simple tube replacement does not restore normal output. The circuits are not critical as to tube quality and replacement may usually be made without adjustment. In extreme cases of tube difference, slight readjustment of the trimmer capacitor may be made as described in paragraph V-7.3.

TABLE V-4. NORMAL JACK READINGS

POSITION	LOW END	HIGH END
J1	-1.0 V	-2.5
J2	-2.0	-8.5
J3	-0.6	-3.6

1. All voltages typical minimum readings.
2. Read with VTVM and with bandswitch in position being tested. Readings will be about 10% lower when using 20,000 ohm per volt meter on the 5 or 10 volt scale. OUTPUT LEVEL set to red line.

c. It is always possible that reduced output (or zero output) may be caused by component failure. In the event that tube replacement does not restore normal output, the bottom cover should be removed and voltages in various parts of the circuit checked against those given on the schematic drawing. It is recommended that the voltages be measured in the following order:

1. Heater.
2. Output of plate supply filter.
3. Output of regulator tube and Zener diode.
4. Plate voltage of each tube at each position of bandswitch (pin 5).
5. Screen voltage of each tube at each position of bandswitch (pin 6).
6. Other voltages, if "1" through "5" are normal.

V-6. VOLTAGE AND RESISTANCE CHARTS

V-6.1. VOLTAGE AND RESISTANCE CHARTS, MODELS SB-12bS AND PS-21.

The voltage and resistance chart, Figure V-1, was made with the analyzer section and power supply interconnected for normal operation.

All readings taken between point specified and chassis ground using an RCA VTVM Model WV-77A.

The following control positions were used:

IF ATTEN	0 DB
SWEEP WIDTH SELECTOR	VAR
BRILLIANCE	Bright Trace
FOCUS	Sharp Trace
AMPLITUDE SCALE	LIN
CENTER FREQ	Marker
AFC	OFF
GAIN	10 (MAX)
CAL OSC LEVEL	OFF
INPUT ATTENUATORS	All up
H POS	Normal Operation
V POS	Normal Operation
SWEEP WIDTH	Maximum (clockwise)
IF BANDWIDTH	Maximum (clockwise)
VIDEO RATE	OFF
SWEEP RATE	Maximum (clockwise)

NOTES

1. Voltage readings above line, resistance readings below line.
2. All voltages are DC unless otherwise specified.
3. All resistances are in ohms.
4. * Indicates a very low resistance.
5. NC Indicates no connection.
6. Q3 and Q4 measurements made with CAL OSC LEVEL control fully clockwise.

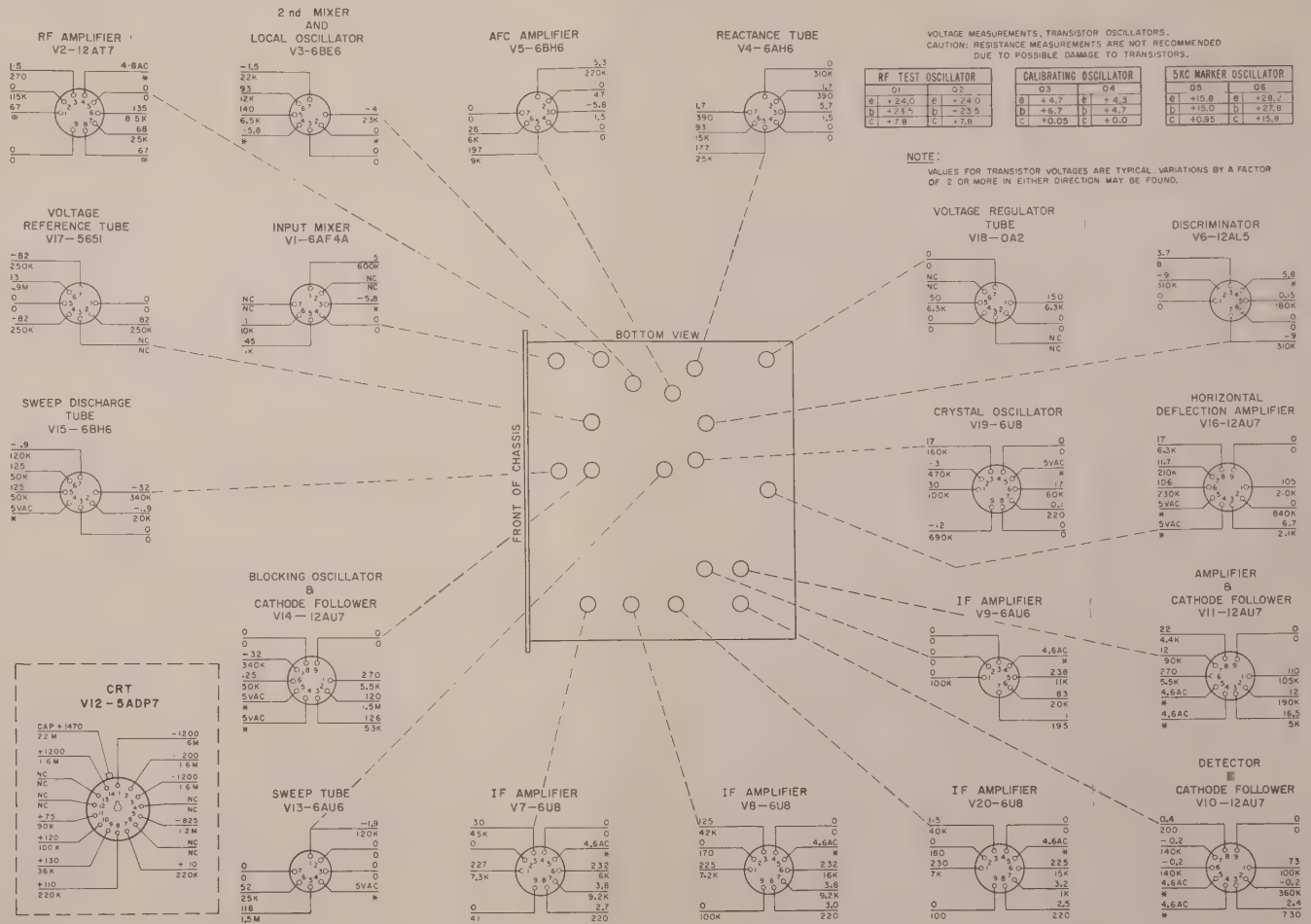


Figure V-1.
Voltage and Resistance Chart, Model SB-12bS.

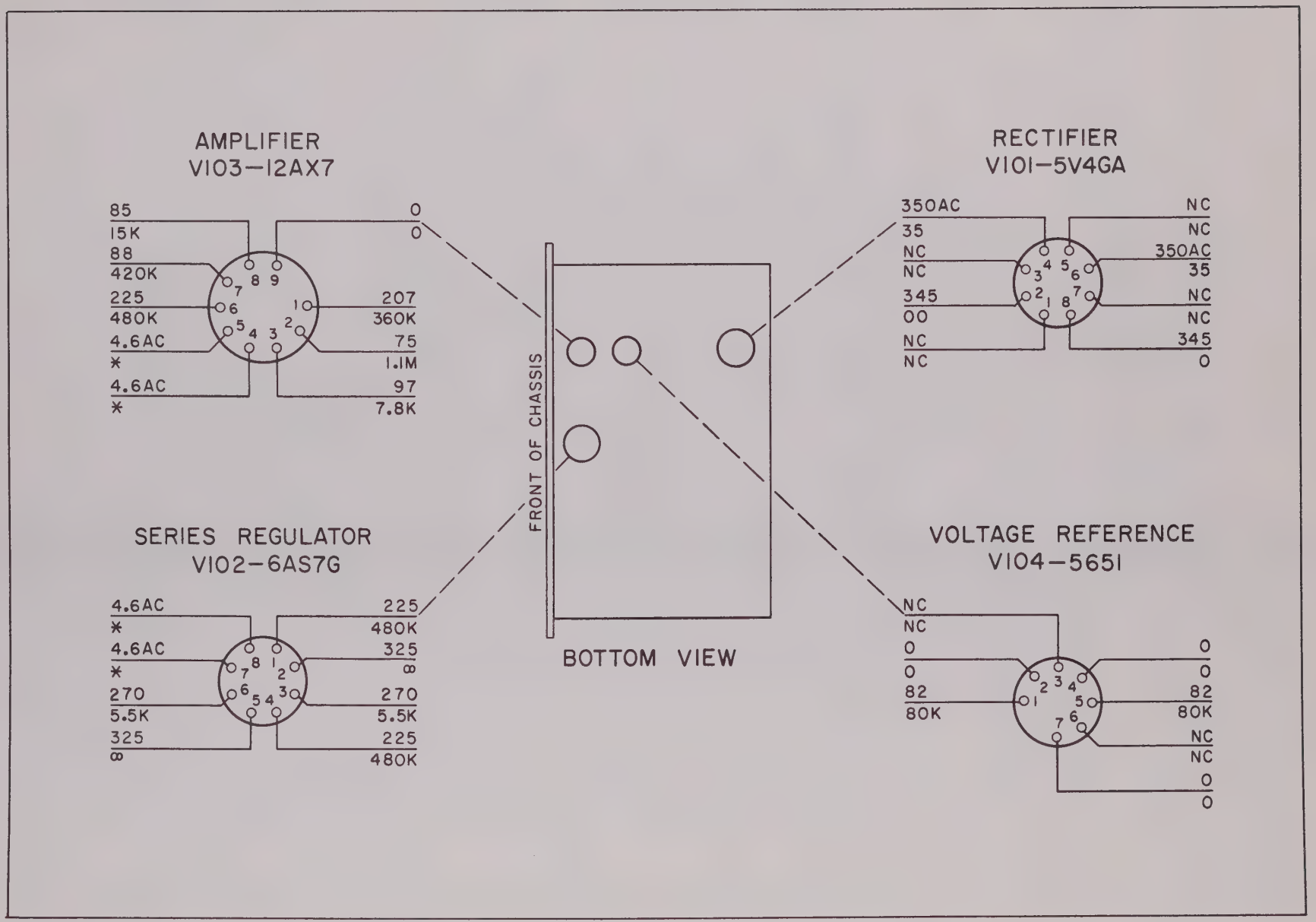


Figure V-2. Voltage and Resistance Chart, Model PS-21.

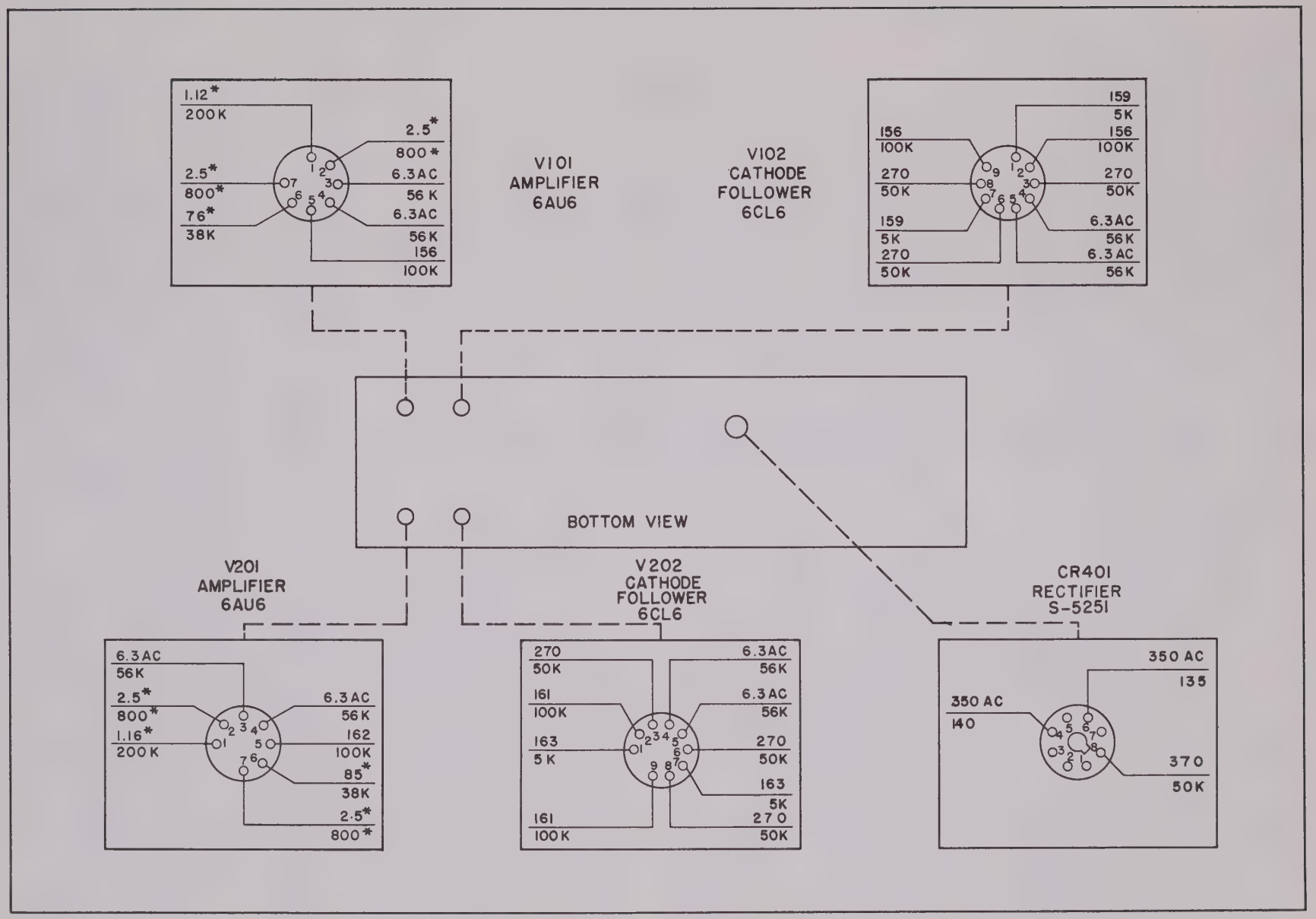


Figure V-3. Voltage and Resistance Chart, Model TTG-2.

V-6.2. VOLTAGE AND RESISTANCE CHART, MODEL TTG-2.

All readings taken between point specified and chassis ground using an RCA VTVM Model WV-77A. The following control positions were used.

FREQUENCY-CPS	All controls counterclockwise
LEVEL, A and B	Counterclockwise
OUTPUT	A
OUTPUT LEVEL	Both fully clockwise
600Ω TERM	IN

NOTES

1. Voltage readings above line, resistance readings below line.
2. All voltages are DC unless otherwise specified.
3. All resistances are in ohms.
4. *Readings vary with screwdriver-adjust control settings.
5. NC indicates no connection.

V-6.3. VOLTAGE AND RESISTANCE CHART, MODEL RF-7a.

See the schematic diagram for voltage and resistance readings at points in the Model RF-7a circuit.

V-7. ALIGNMENT PROCEDURE

V-7.1. ALIGNMENT PROCEDURE, MODEL SB-12bS.

The following is a complete factory alignment procedure. It should be used only after touch-up alignment techniques have been tried and have failed to yield satisfactory results.

a. General.

1. Transformers T101, T102, Z101, Z102, Z103 and Z105 are tuned by means of movable iron cores. Windings at the top of the coil are tuned with a hollow iron core which may be turned with the pin end of the aligning tool furnished.

The bottom windings may be tuned from either the top or the bottom of the transformer. In either case the screwdriver tip of the aligning tool is used. When the bottom core is approached from the top, the tool is inserted through the hollow top core and finally engaged in a slot in the top of the lower core. Allow the Panoramic equipment and necessary signal generator to "warm-up" for at least one-half hour before alignment is attempted.

2. Set the front panel controls as follows:

IF ATTEN	0 DB
SWEEP WIDTH SELECTOR	VAR
BRILLIANCE	Bright Trace
FOCUS	Sharp Trace
AMPLITUDE SCALE	LIN
CENTER FREQ	To Marker
AFC	OFF
GAIN	10 (Maximum)
CAL OSC LEVEL	OFF
INPUT ATTENUATORS	All Up
H POS	For Normal Operation
V POS	For Normal Operation
SWEEP WIDTH	Maximum (clockwise)
IF BANDWIDTH	Maximum (clockwise)
VIDEO FILTER	OFF
SWEEP RATE	Maximum (clockwise)

b. I-f Amplifier Alignment.

1. The frequencies involved in i-f alignment are:

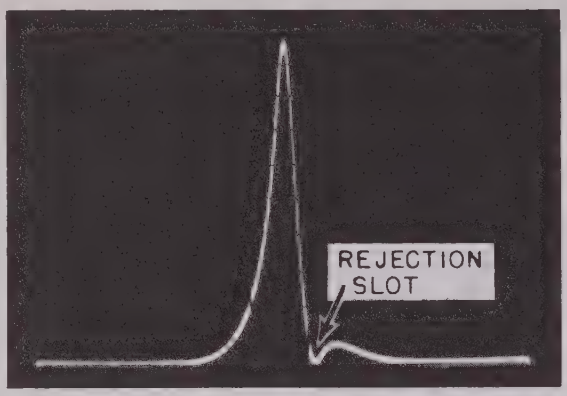
MODEL	INPUT CENTER FREQ	IF
SB-12bS	500 KC	100 KC

2. Connect a .01 mfd capacitor in series with the output of the signal generator and proceed as follows:

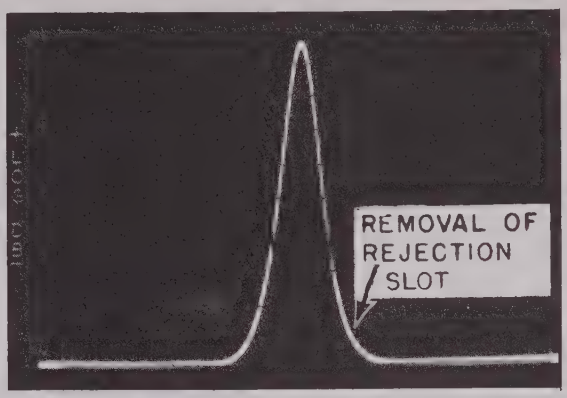
I-f AMPLIFIER ALIGNMENT PROCEDURE

Step	Sig. Gen. Output	Sweep Width Control at	Signal Fed to	Procedure
1	100 KC (40,000 uv)	Minimum	Pin 1 V9 6AU6	Tune top and bottom cores of Z105 for maximum baseline rise. When either core is tuned for maximum deflection, no further tuning is required because windings are in parallel.

Step	Sig. Gen. Output	Sweep Width Control at	Signal Fed to	Procedure
2	Same as above	Same as above	Pin 7 V3 6BE6	Tune top and bottom cores of Z103 for maximum baseline rise possible with each.
3	500 KC (700 uv)	Maximum	Pin 7 V3 6BE6	Adjust the CENTER FREQ control and, if necessary, the CF PAD control to center the pip on the screen. Gradually reduce the sweep width, at the same time continuously readjusting the CENTER FREQ control to keep the pip on the screen until the base of the pip occupies approximately 25 per cent of the frequency scale.
4	500 KC	Adjust continuously as required to keep the entire pip within screen limits.	Same as above	Mark the position of crystals in their sockets. Holder capacity varies with position; therefore, it will be important, when replacing the crystals, to preserve their orientation with respect to the socket. Remove crystals Y301 and Y302.
5	------	----------	----	A neutralizing capacitor is mounted near each crystal on the underside of the i-f strip. These capacitors are to be tuned with the screwdriver end of the aligning tool furnished. Each capacitor tunes the crystal nearest to it.
6	------	----------	----	Set the BANDWIDTH LIMIT control to the center of its rotational range. At this point pip should approximate the shape shown in Figure V-4A or V-4B.
7	------	----------	----	Gradually rotate the trimmer screw of the capacitor nearest Y303 in a counterclockwise direction, and note the change in pip shape. The rejection slot should sharpen and disappear on one side of the pip and approach from the other side.
8	------	----------	----	Reverse the rotation and choose a point where best pip symmetry is obtained and a rejection slot is not present. (Approximately halfway between the two positions at which the slot enters the pip from either side. See Figure V-4B.)
9	------	----------	----	Tune coil L101C for a minimum height and a broadest pip. Note that as the core is moved from one end of its range to the other, the pip will broaden and decrease in amplitude until a condition of minimum height and broadest



A. Illustration of Rejection Slot.



B. Illustration of Complete Rejection Slot Removal.

Figure V-4. Crystal Rejection Slot Removal.

Step	Sig. Gen. Output	Sweep Width Control at	Signal Fed to	Procedure
				pip is reached. Continued rotation will cause the pip to sharpen and increase in amplitude. (As the pip decreases in amplitude it may be necessary to increase the amplitude of the input signal to maintain a readable deflection on the screen.)
10	------	----------	----	Check for correct rejection slot removal by adjusting sweep width until pip base occupies approximately 25 per cent of the screen baseline. Set the input amplitude for a full-scale deflection. Increase input amplitude by ten times. Set AMPLITUDE SCALE selector to LOG. If the pip is not full-scale, set the LOG SCALE ADJ control for a full-scale pip. Pip should remain approximately symmetrical and no rejection slot should appear. If it does appear, readjust trimmer slightly to remove it and retune as in step 9. Reduce the input amplitude 10 times and set the AMPLITUDE SCALE selector to LIN.
11	------	----------	----	Remove crystal Y303.
12	------	----------	----	Insert crystal Y302 in its socket. Repeat the procedure given in steps 5 through 10 using the capacitor nearest crystal Y302 and coil L101B.
13	------	----------	----	Remove crystal Y302.
14	------	----------	----	Insert crystal Y301 in its socket. Repeat the procedure given in steps 5

Step	Sig. Gen. Output	Sweep Width Control at	Signal Fed to	Procedure
				through 10, using the capacitor nearest crystal Y301 and coil L101A.
15	------	----------	----	Replace crystals Y302 and Y303 in the same orientation they have prior to removal. Repeat step 10 with all crystals installed but omit reference to step 9. If trimmer adjustment is required make small gradual changes in the trimmer settings. If there is no change when adjusting one of the trimmers restore it to its original setting and adjust one of the other trimmers.
16	------	----------	----	Adjust BANDWIDTH LIMIT control for the broadest (without double peak) symmetrical peak possible without more than a 20 per cent drop in amplitude as the SWEEP WIDTH control is changed from a maximum counterclockwise position to a maximum clockwise position.

c. F-m Oscillator Alignment. The following adjustments are a series of approximations, which are narrowed down until the desired results are obtained.

1. Set the Sweepwidth Limit control fully clockwise.

2. Adjust the CF PAD for +85 volts, measured between the arm of the CF PAD and ground.

3. Set the front panel CAL OSC LEVEL control fully clockwise.

4. Adjust the GAIN control for a full scale pip.

5. Connect an accurate 50 KC signal source to the front panel EXT MOD connector. Adjust the output amplitude for usable sidebands (approximately 1/4 scale).

6. Adjust the core of Z101 to center the oscillator (center) pip on the screen.

7. Adjust the Sweepwidth Limit control to place the ±50 KC sideband pips directly under the ±50 vertical screen calibrations. If necessary, make slight centering readjustments with the CF PAD.

8. Check linearity by noting the location of the center pip relative to the vertical CF screen calibration. Linearity is within specifications if, with ±50 KC pips directly under the ±50 vertical screen calibrations, the center pip is within ±1/4 of a division of the CF screen calibration.

9. If linearity is not within specifications, rotate the CF PAD slightly in a clockwise direction and recenter the display with Z101. Recheck linearity as in steps 7 and 8.

10. Repeat steps 7, 8 and 9 until the sweep width and linearity are correct.

d. R-f Alignment. The r-f transformers used in this equipment have sliders. This makes it possible to adjust the spacing between the primary and secondary so as to obtain the proper frequency separation between the peak frequencies. If the frequency separation is correct, then it is only necessary to trim the cores of two r-f transformers until the desired flatness is obtained. If the frequency separation is not correct, the full alignment procedure must be used. The sliders have been waxed down to prevent movement. If it is necessary to change the position of the sliders, the waxing must be removed. Upon completion of the alignment procedure, rewax the coils to prevent movement.

This alignment requires a "cut and try" procedure. The frequency response of the section is determined by feeding in constant amplitude signals at various frequencies over the r-f band of the equipment.

1. First adjust C107.

(a). Temporarily clip a 51,000 ohm, 1/2 watt resistor between the junction of R107 and R109 and B+.

(b). Set the GAIN control almost completely counterclockwise (at the first scale division from the counterclockwise end).

(c). Connect a 500 KC signal source to the front panel SIGNAL INPUT connector. Adjust the amplitude of the input signal, to give an approximately 1/4 scale pip. If necessary, adjust the GAIN control slightly to give the required pip height.

(d). Adjust C107 for a minimum pip deflection.

(e). Remove the 51,000 ohm resistor.

2. Then align the interstage transformer T102.

(a). Make the spacing between the primary and secondary windings approximately 1/4".

(b). Using a .01 mfd coupling capacitor, feed a 500 KC signal to pin 6 of V2. Tune the secondary (bottom core) of T102 for a peak deflection at the center of the screen.

(c). Apply a 515 KC signal to pin 2 of V2. Tune the primary (top core) for a peak deflection.

(d). Shift the signal generator frequency to 485 KC. Tune the secondary (bottom core) of T102 for a peak deflection.

(e). Vary the signal generator frequency between the high and low frequency peaks as read on the screen of the equipment. The peaks should appear at approximately 515 KC and at 485 KC.

If the frequency separation is greater than specified, increase the coil spacing.

If the frequency separation is less than specified, decrease the coil spacing.

(f). Repeat steps (c), (d) and (e) until peak deflections and the proper frequency separation are obtained.

3. Then align the input transformer T101.

(a). Make the spacing between the primary and secondary windings approximately 1/16".

(b). Connect the signal generator to pin 5 of V1 and set the frequency to 500 KC. Tune the secondary (bottom core) of T101 for a peak deflection at the center of the screen.

(c). Apply a 550 KC signal to the SIGNAL INPUT connector through the input cable. Tune the primary (top core) of T101 for maximum pip amplitude.

(d). Set the signal generator to 450 KC. Tune the secondary (bottom core) of T101 for maximum pip amplitude.

(e). Vary the signal generator frequency between 450 KC and 550 KC noting the frequency separation between the high and low frequency peaks as read on the screen. The peaks should appear at 450 KC and at 550 KC.

If the frequency separation is greater than specified, increase the coil spacing.

If the frequency separation is less than specified, decrease the coil spacing.

(f). Repeat steps (c), (d) and (e) until peak deflections and the proper frequency separation are obtained.

4. Adjust the cores of r-f transformer T102 for proper flatness as follows:

Step	Sig. Gen. Output	Signal Fed to	Transformer Tuned	Procedure
(1)	450 KC then 550 KC	SIGNAL INPUT Connector	T102	If the 450 KC pip is taller than the 550 KC pip, adjust for equal amplitude by trimming the bottom core clockwise. On the other hand, if the 550 KC pip is the taller of the two, trim the bottom core counterclockwise and the top core clockwise.

Step	Sig. Gen. Output	Signal Fed to	Transformer Tuned	Procedure
(2)	450 KC 500 KC 550 KC	SIGNAL INPUT Connector	T102	If the 450 KC and 550 KC pips are taller than the 500 KC pip, trim the top and bottom cores clockwise. If they are lower, trim both cores counterclockwise.
(3)	------	-------	----	Repeat (1) and (2) until response flatness is within ±5%.

e. Discriminator Alignment.

1. Before adjusting the discriminator, the CF PAD must be adjusted according to the procedure given in paragraph V-4.1.h.

2. Center the pip on the screen with the SWEEP WIDTH SELECTOR in the 3.5 KC position. Switch it to the 500 cps position. The pip should appear near the center of the screen. If it does, switch to the 150~ range and repeat the check. If the pip is off-screen or cannot be centered on one or more of these ranges, it will be necessary to adjust the DISC ZERO located on top of Z102, using the insulated tool supplied with the Panalyzor.

(a). Starting on the narrowest sweep range for which a pip can be seen, carefully adjust DISC ZERO to center the pip. This procedure may be expedited by using the FAST SWEEP, but the final check must be done at a 0.1 cps sweep rate.

(b). Following this adjustment, proceed to the next narrower sweep width and repeat. The final adjustment should be on the 150 cps sweep width. When this has been adjusted, the pip will be approximately centered on all sweep ranges.

NOTE

The DISC ZERO adjustment is very critical, particularly on the narrowest sweep width. It will usually be necessary to move the adjustment through the correct point several times before the final setting is obtained.

f. HUM ADJ. Using a 150 cps sweep width, display a signal from the 500 kc/s CAL OSC LEVEL control. Observe 60 cycle hum sidebands on CRT. Adjust the HUM ADJ potentiometer R223 in small increments until the hum sidebands are minimized. Verify that the hum is below -60 db relative to signal amplitude.

V-7.2. ALIGNMENT PROCEDURE, MODEL TTG-2.

No alignment of Model TTG-2 is necessary.

V-7.3. ALIGNMENT PROCEDURE, MODEL RF-7a.

a. The maintenance of optimum performance of the Model RF-7a is dependent upon tracking accuracy. When adjusted before shipment, the tracking is adjusted for minimum deviation and, with the exception of compensation of minimum capacitance required by tube changes, should not require realignment in the field.

Since the tracking accuracy is dependent upon tube capacitance, a tube change might conceivably require readjustment of the trimmer capacitor. This will be indicated by inability to obtain normal output at the high end of the band even changing tubes and with all other measurements apparently normal. The greatest source of variation is in the grid circuit; therefore, the trimmer capacitor in the plate circuit of the tube preceding the one changed should be rotated slightly until maximum output is obtained. The procedure should also be followed in the plate circuit of the tube in question if returning the preceding stage does not produce the full effect.

In the event that the tracking has been disturbed, the following field procedure is recommended to restore it to normal.

1. Rotate the knob until the dial reads between 2.2 and 2.3 MC. Load the oscillator with 50 ohms (proper termination is important), adjust the appropriate inductor for maximum meter reading in each bandswitch position.

2. Rotate the knob until the dial reads 4.2 to 4.3 MC. Adjust the appropriate capacitor associated with each bandswitch position for about 90% of the "peaked" meter reading on the side from which the peak was originally approached.

3. Repeat 1 and 2 above. The tracking,

while not perfect, will now be satisfactory for general usage.

b. Aside from the possibility of slippage of set-screws within the gear drive, the only other likely source of tracking error is loosening of the cable which drives the tuning capacitor. This is a 50 pound test stainless steel pre-stressed cable and should last the normal service life of the Model RF-7a. If, however, it should be noticed that the output varies radically with small knob rotation, (3-5 turns) then the condition of the cable should be investigated. After removing the top cover, check the cable tension by pushing lightly across the cable. If it is loose, release the set-screw holding the idler pulley bracket and rotate it to restore proper cable tension. DO NOT OVERTIGHTEN. The cable tension may also be tested by attempting to rotate the capacitor by hand, simultaneously observing the cable. If it permits the capacitor to turn and visibly introduces slack in the cable, increase the tension as outlined above.

c. If it is found necessary to remove the oscillator from the main chassis for lubrication or because of trouble, the following procedure should be observed (power off) -

1. Rotate the knob until the dial reads exactly 2.0 MC.

2. Remove the two 6-32 screws (1 top - 1 bottom) holding the magnetic shield to the oscillator mounting plate.

3. Loosen the set screws on the flexible coupling on the end nearest the oscillator.

4. Unsolder oscillator power leads.

5. Remove coaxial output connector P3.

6. Remove the three #6 nuts holding the oscillator to the mounting bracket.

7. Slide the oscillator back to disengage coupling and lift out.

8. Remove the three screws holding the oscillator cover, being careful not to turn the oscillator shaft, and slide off cover.

To replace the oscillator, follow steps 2 to 8 above in reverse order.

d. In order not to disturb the MAIN TUNING dial calibration, it is advisable that the shaft not be rotated during this operation. However, if it has been, it may be reset approximately by rotating it 1/2 turn in the clockwise direction from the counterclockwise stop position. If, after installation, the calibration is found to be off by more than 30 KC at any point on the dial, it can be set closer by the use of a frequency counter or other accurate standard. If this is necessary, the following procedure is recommended.

1. Set the FREQUENCY RANGE switch to the 2.5 - 5.0 MC position.

2. Couple the output of the Model RF-7a to the counter by means of a 6 to 10 db coaxial pad (to provide proper termination).

3. With the dial set to 2.0 MC, loosen the set screws nearest the panel on the coupling nearest the gear drive. Rotate the oscillator shaft slightly until the frequency reads 2.5 MC ± 5 KC. Tighten set screws. Check the frequency at other points over the dial and reset the oscillator, if necessary, for minimum frequency deviation over the entire range.

4. Replace magnetic shield.

V-8. LIST OF REPLACEABLE PARTS

a. This parts list section includes all pertinent data necessary to locate, identify, and procure additional parts for the equipment. Parts are listed alpha-numerically by reference symbol and include all replaceable items such as electronic and electromechanical and mechanical parts of the equipment.

In some cases, values, ratings and manufacturer sources shown are nominal and variations may be found. Satisfactory replacement may be made with either the listed component or an exact replacement of the part(s) removed from the equipment.

V-8.1 ORDERING INFORMATION.

The following instruction will aid in ordering parts from the Parts List.

a. Address all inquires or orders to:

CUSTOMER SERVICE
Department 500-1
The Singer Company
Metrics Division
915 Pembroke Street
Bridgeport, Conn. 06608

b. Include the following information:

1) Model and Serial Number of instrument.
2) Singer Part Number.
3) Reference Symbol Number.
4) Description (as shown on list).

V-8.2 HOW TO USE THE PARTS LIST.

The paragraphs below describe the use and meaning of the five columns included in the parts list.

a. REF SYMBOL Column. The REF SYMBOL column contains an alpha-numerical listing of parts as they appear on equipment chassis, illustrations or schematics. The reference designation identifies the parts as to their component function in the instrument.

b. DESCRIPTION Column. The DESCRIPTION column contains the identification of component parts including all pertinent specifications and Singer part number. When the DESCRIPTION column is used for a part which is identical to a part which has already been described, SAME AS is used along with the reference symbol number of the previously used part. In these instances, columns 3, 4 and 5 are left blank. When the DESCRIPTION column is used for a reference symbol number for which no part exists, NOT USED is placed in the column. In these instances, columns 3, 4 and 5 are left blank.

c. MANUFACTURER'S PART NUMBER Column. The MANUFACTURER'S PART NUMBER column contains the part number as described by the manufacturer of the part.

d. MFR'S CODE Column. The MFR'S CODE column references the manufacturer by an assigned code number as listed in the Federal Supply Code Handbook H4-2. For manufacturers not listed in H4-2, a letter code will be assigned. Table V-5 includes the manufacturer and his code designation.

e. MAINT QTY Column. The MAINT QTY column contains the number of additional components recommended to keep the equipment at an optimum performance level. The recommended number of components in the MAINT QTY column is based on 2000 hours of equipment operation.

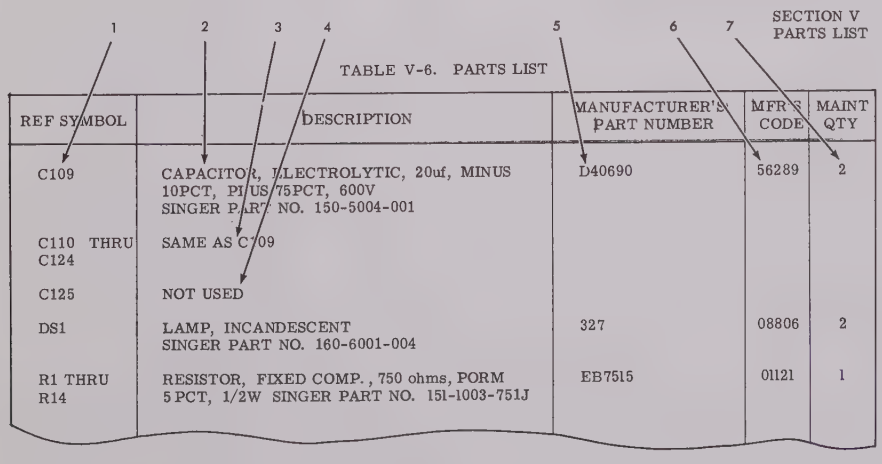


Figure V-5. Parts List Sample

TABLE V-5. MANUFACTURER'S CODE

Number	Name
00656	Aerovox Corp. New Bedford, Mass.
00853	Sangamo Electric Co. Pickens Division Pickens, S. C.
01009	Alden Products Co. Brockton, Mass.
01121	Allen-Bradley Co. Milwaukee, Wis.
01875	Wright Electronic Inc. Kansas City, Mo.
02660	Amphenol-Borg Electronics Corp. Maywood, Ill.
04009	Arrow-Hart and Hegeman Electric Co. Hartford, Conn.
04713	Motorola Inc. Semiconductor Products Division Phoenix, Arizona
08806	General Electric Co. Miniature Lamp Department Cleveland, Ohio
09023	Cornell-Dubilier Electric Corp. Electrolytics and Paper Tubular Division Sanford, N. C.
11190	Budelman Electronics Corp. Now Part of General Signal Corp. Woodbury, L. I., N. Y.
12126	Kidco Inc. Medford, N. J.
14655	Cornell-Dubilier Electric Corp. Newark, N. J.
14841	Ward Leonard Electric Co. Hagerstown, Md.
16665	The Singer Company Metrics Division Bridgeport, Conn.
24455	General Electric Co. Lamp Division Nela Park, Cleveland, Ohio
44655	Ohmite Mfg. Co. Skokie, Ill.
53021	Sangamo Electric Co. Springfield, Ill.
56289	Sprague Electric Co. North Adams, Mass.
71400	Bussmann Mfg. Division of McGraw Edison Co. St. Louis, Mo.
71450	CTC Corp. Elkhart, Ind.
71590	Centralab Division of Globe-Union Inc. Milwaukee, Wis.
71700	Cornish Wire Co. New York, N. Y.
71785	Cinch Mfg. Co. & H. B. Jones Division Chicago, Ill.
72136	Electric Motive Mfg. Co. Inc. Willimantic, Conn.
72619	Dialight Corp. Brooklyn, N. Y.
72825	EBY Hugh Inc. Philadelphia, Pa.
72982	Erie Technological Products Inc. Erie, Pa.
73559	Carling Electric Inc. Hartford, Conn.
73899	J. F. D. Electronics Corp. Brooklyn, N. Y.
74545	Harvey Hubbell Inc. Bridgeport, Conn.
74970	E. F. Johnson Co. Waseca, Minn.
75042	International Resistance Co. Philadelphia, Pa.
75382	Kulka Electric Corp. Mt. Vernon, N. Y.
75915	Littlefuse Inc. Des Plaines, Ill.
76487	James Millen Mfg. Co. Inc. Malden, Mass.
76493	J. W. Miller Co. Los Angeles, Calif.
76854	Oak Mfg. Co. Crystall Lake, Ill.

TABLE V-5. MANUFACTURER'S CODE (Cont'd)

Number	Name
77630	TRW Electronic Components Division Camden, N. J.
77638	General Instrument Corp. Semiconductor Products Group Rectifier Division Brooklyn, N. Y.
78488	Stackpole Carbon Co. St. Marys, Pa.
80009	Tektronix Inc. Beaverton, Oreg.
80183	Sprague Products Co. North Adams, Mass.
80223	United Transformer Co. New York, N. Y.
81349	Military Specifications
81483	International Rectifier Corp. El Segundo, Calif.
82389	Switchcraft Inc. Chicago, Ill.
82893	Vector Electronic Co. Glendale, Calif.
83322	Paramount Rubber Co. Detroit, Mich.
83330	Herman H. Smith Inc. Brooklyn, N. Y.
84970	Sarkes Tarzian Inc. Bloomington, Ind.
86684	Radio Corp. of America Electronic Components and Devices Harrison, N. J.
90201	P. R. Mallory and Co. Inc. Detroit, Mich.
91418	Radio Materials Co. Chicago, Ill.
91662	Elco Corp. Willow Grove, Pa.
92294	Allen B. DuMont Lab. Inc. New York, N. Y.
92364	Olivetti Underwood Corp. Bridgeport, Conn.
94310	TRU-OHM Products Memcor Components Division Huntington, Ind.
96906	Military Standard
98977	O. B. Wise Co. Knoxville, Tenn.
99848	Wilco Corp. Indianapolis, Ind.

TABLE V-6 PARTS LIST (SB-12bS)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
CR1	SEMICONDUCTOR DEVICE DIODE SINGER PART NO. 556118-021	C1151B1S1G	77638	1
C101	CAPACITOR,CERAMIC,0.05 UF,PLUS 80 PCT,MINUS 20 PCT 500 V SINGER PART NO.556060-081	82700025V503Z	80183	1
C102	CAPACITOR,CERAMIC,0.01 UF,500 V SINGER PART NO. 556060-012	6TM31	80183	1
C103	CAPACITOR,PAPER,0.1 UF,400 V SINGER PART NO. 556120-019	330401	00853	1
C104 THRU C106	SAME AS C102			
C107	CAPACITOR,VARIABLE,1 TO 5 UF SINGER PART NO. 556122-012	VC5	73899	1
C108	SAME AS C101			
C109	SAME AS C103			
C110	NOT USED			
C111	CAPACITOR,COMP.,0.68UUF,PORM 20 PCT, SINGER PART NO. 150-4001-R68M	TYPE GA	78488	1
C112 THRU C200	NOT USED			
C201ABC	CAPACITOR,PAPER,DIELECTRIC,3 X 0.1 UF,600 V SINGER PART NO. 556111-010	7710BRN	72982	1
C202	CAPACITOR,MICA,51UUF,PORM 5 PCT SINGER PART NO. 556078-011	CM15C510J	81349	1
C203	SAME AS C102			
C204	CAPACITOR,MICA,1000UUF,PORM 5 PCT, SINGER PART NO. 556086-001	CM25E102J	81349	1
C205	CAPACITOR,MICA,270UUF,PORM 5 PCT, SINGER PART NO. 556078-013	CM15C271J	81349	1
C206	CAPACITOR,ELECTROLYTIC,2000 UF,15 V SINGER PART NO. 556062-003	TVL1168	80183	1
C207	CAPACITOR,PAPER,METALIZED,0.47 UF,200 V SINGER PART NO. 556120-103	P123ZNP	00656	1
C208 AND C209	NOT USED			
C210	CAPACITOR,MICA,5100UUF,PORM 5 PCT, SINGER PART NO. 556092-006	CM35E512J	81349	1
C211	NOT USED			
C212	CAPACITOR,MICA,DIPPED,240UUF,PORM 5 PCT,500V SINGER PART NO. 150-2002-241EJO	DM15E240J0500WV4CR	72136	1
C213	CAPACITOR,VARIABLE,3.2 TO 50UUF SINGER PART NO. 556060-173	148-4	74970	1
C214 THRU C300	NOT USED			

TABLE V-6 PARTS LIST (SB-12bS)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
C301	SAME AS C201			
C302	CAPACITOR,MICA,100UUF,PORM 5 PCT, SINGER PART NO. 556082-014	CM20C101J	81349	1
C303	CAPACITOR,VARIABLE,3 TO 12UUF,350 V SINGER PART NO. 556122-030	TYPE 557-000	72982	1
C304	SAME AS C101			
C305	CAPACITOR,PAPER,TUBULAR,0.47 UF,PORM 10 PCT, 300 V SINGER PART NO, 556120-058	86P4793T15	56289	1
C306	SAME AS C303			
C307	SAME AS C305			
C308	SAME AS C101			
C309	CAPACITOR,MICA,100UUF,PORM 5 PCT SINGER PART NO. 556078-012	CM15C101J	81349	1
C310	SAME AS C101			
C311	CAPACITOR,MICA,470UUF,PORM 5 PCT, SINGER PART NO. 556082-013	CM20C471J	81349	1
C312	SAME AS C205			
C313 AND C314	SAME AS C102			
C315	SAME AS C303			
C316 THRU C320	SAME AS C101			
C321	SAME AS C302			
C322	SAME AS C102			
C323	NOT USED			
C324	SAME AS C302			
C325 THRU C327	SAME AS C101			
C328	SAME AS C305			
C329 THRU C400	NOT USED			
C401	CAPACITOR,PAPER,TUBULAR,0.047 UF,400 V SINGER PART NO. 556120-149	81P4739451	80183	1
C402	CAPACITOR,PAPER,DIELECTRIC,4 UF,600 V SINGER PART NO. 556106-007	SB1K6474K	00853	1
C403	SAME AS C202			
C404	NOT USED			
C405	SAME AS C207			
C406	NOT USED			

TABLE V-6 PARTS LIST (SB-12bS)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
C407	CAPACITOR,PAPER,DIELECTRIC,3 X 0.1 UF,600 V SINGER PART NO. 556114-008	TYPE CP69	56289	1
C408	NOT USED			
C409	CAPACITOR,MYLAR,0.1 UF,PORM 10 PCT,100 V SINGER PART NO. 556120-130	WMF1F1E	09023	1
C410 THRU C500	NOT USED			
C501	SAME AS C309			
C502	SAME AS C102			
C503	CAPACITOR,MYLAR,0.1 UF,200 V SINGER PART NO. 556120-098	338C104M	80183	1
C504	NOT USED			
C505	CAPACITOR,MICA,1000UUF,PORM 5 PCT, SINGER PART MO. 556081-045	CM20E102J	81349	1
C506	CAPACITOR,MICA, 10UUF,PORM 5 PCT SINGER PART NO. 556081-001	CM20C100J	81349	1
C507 AND C508	CAPACITOR,CERAMIC,0.05 UF,PLUS 80,PCT,MINUS 20 PCT,500 V SINGER PART NO 556074-055	TYPE 5GA	56289	1
C509	NOT USED			
C510	CAPACITOR,ELECTROLYTIC,4 X 20 UF,475 V SINGER PART NO. 556066-002	TVL4840	56289	1
C511 THRU C700	NOT USED			
C701	CAPACITOR,MICA,560UUF,PORM 5 PCT, SINGER PART NO. 556076-001	CM15E561J	81349	1
C702	CAPACITOR,MICA,910UUF,PORM 5 PCT, SINGER PART NO. 556084-006	CM20E911J	81349	1
C703	CAPACITOR,CERAMIC,0.02UUF,500 V SINGER PART NO. 150-1002-203ZZH	29C187A	80183	1
C704	CAPACITOR,MICA,470UUF,PORM 5 PCT SINGER PART NO. 556078-014	CM15E471J	81349	1
C705	NOT USED			
C706	SAME AS C703			
C707	SAME AS C103			
C708	CAPACITOR,CERAMIC,0.02 UF,500 V SINGER PART NO. 556060-023	TYPE 861	72982	1
C709	SAME AS C309			
C710 THRU C712	NOT USED			
C713	SAME AS C309			
C714	NOT USED			

TABLE V-6 PARTS LIST (SB-12bS)

Ref Symbol		Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
C715		SAME AS C503			
C716		NOT USED			
C717		SAME AS C507			
C718 C800	THRU	NOT USED			
C801		CAPACITOR,MICA,6800UUF,PORM 5 PCT, SINGER PART NO. 556095-001	CM35D682J	81349	1
C802		NOT USED			
C803		CAPACITOR,MICA,0.01 UF,PORM 5 PCT, SINGER PART NO. 556096-001	CM35E103J	81349	1
C804		NOT USED			
C805		SAME AS C803			
C806		NOT USED			
C807		CAPACITOR,ELECTROLYTIC,10 UF,12 V SINGER PART NO. 556074-001	TE1128	80183	1
C808		NOT USED			
C809		SAME AS C807			
C810		NOT USED			
C811		SAME AS C503			
C812		NOT USED			
C813		CAPACITOR,MICA,820UUF,PORM 5 PCT, SINGER PART NO. 556082-027	CM20C821J	81349	1
E1		CONNECTOR,HIGH VOLTAGE ANODE SINGER PART NO. 556023-079	118525	71785	1
I1 I5	THRU	LAMP,INCANDESCENT SINGER PART NO. 160-6001-002	349	08806	10
J1 J3	THRU	NOT USED			
J4		CONNECTOR,FEMALE,5 CONTACTS SINGER PART NO. 556010-035	MS3102A14S5S	81349	1
J5 J100	THRU	NOT USED			
J101		CONNECTOR SINGER PART NO. 556016-313	UG-296/U	81349	1
J102		NOT USED			
J103 J104	AND	CONNECTOR. SINGER PART NO. 556010-043	UG909/U	81349	1
J105 J400	THRU	NOT USED			
J401		CONNECTOR,BNC SINGER PART NO. 556010-038	UG-1094/U	81349	1

TABLE V-6 PARTS LIST (SB-12bS)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
J402	CONNECTOR,RECEPTACLE,FEMALE,10 CONTACTS SINGER PART NO. 556010-030	MS3102A181S	81349	1
J403 THRU J500	NOT USED			
J501	CONNECTOR,MALE,14 CONTACTS SINGER PART NO. 556016-011	MS3102A28-2P	81349	1
J502	SAME AS J401			
J503 THRU J700	NOT USED			
J701	SAME AS J401			
L100	NOT USED			
L101A THRU L101C	COIL	556026-090	16665	1
L102 THRU L200	NOT USED			
L201	CHOKE,0.66 UH SINGER PART NO. 556012-013	9310-8	76493	1
L202 THRU L300	NOT USED			
L301	CHOKE,2.5 MH SINGER PART NO. 556012-016	6302	76493	1
L302 THRU L700	NOT USED			
L701	CHOKE,100 MH	556012-001	16665	1
P400 AND P401	NOT USED			
P402	CONNECTOR,PLUG,MALE,10 CONTACTS SINGER PART NO. 556016-045	MS3106A181P	81349	1
Q1 THRU Q6	TRANSISTOR SINGER PART NO. 556160-680	2N404	81349	1
R100	NOT USED			
R101 AND R102	RESISTOR,FIXED,COMP.,51 OHMS,PORM 5 PCT,1/2W SINGER PART NO. 151-1003-510J	RC20GF510J	81349	1
R103	RESISTOR,FIXED,COMP.,1K OHMS,PORM 5 PCT,1/2W SINGER PART NO. 151-1003-102J	RC20GF102J	81349	2
R104	NOT USED			
R105	RESISTOR,FIXED,COMP.,1/K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-103J	RC20GF103J	81349	2
R106	RESISTOR,FIXED,COMP.,270K OHMS,PORM 5 PCT, 1W SINGER PART NO. 151-1004-274J	RC32GF274J	81349	1
R107	RESISTOR,FIXED,COMP.,270 OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-271J	RC20GF271J	81349	1
R108	RESISTOR,VARIABLE,3K OHMS,PORM 10 PCT,2W	151-0007-011	16665	1

TABLE V-6 PARTS LIST (SB-12bS)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
R109 AND R110	RESISTOR,FIXED,COMP.,47K OHMS,PORM 5 PCT,1W SINGER PART NO. 151-1004-473J	RC32GF473J	81349	2
R111	RESISTOR,FIXED,COMP.,2.2K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-222J	RC20GF222J	81349	2
R112	RESISTOR,FIXED,COMP.,30K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-303J	RC20GF303J	81349	1
R113	RESISTOR,FIXED,COMP.,5.1K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-512J	RC20GF512J	81349	1
R114	SAME AS R103			
R115	RESISTOR,FIXED,COMP.,51K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-513J	RC20GF513J	81349	2
R116 THRU R200	NOT USED			
R201	RESISTOR,FIXED,COMP.,15K OHMS,PORM 5 PCT,1W SINGER PART NO. 151-1004-153J	RC32GF153J	81349	1
R202	SAME AS R111			
R203	RESISTOR,VARIABLE,100K OHMS,PORM 10 PCT,2W	151-0007-022	16665	1
R204	SAME AS R111			
R205	RESISTOR,FIXED,COMP.,22K OHMS,PORM 5 PCT,2W SINGER PART NO. 151-1005-223J	RC42GF223J	81349	1
R206 AND R207	RESISTOR,VARIABLE,CONCENTRIC,50 OHM / 500 OHMS,10 PCT,2W	556054-003	16665	1
R208	RESISTOR,FIXED,COMP.,200 OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-201J	RC20GF201J	81349	2
R209	RESISTOR,FIXED,COMP.,4.7 MEGOHMS,PORM 10 PCT 1/2W SINGER PART NO. 151-1003-475K	RC20GF475K	81349	1
R210	RESISTOR,FIXED,COMP.,220K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-224J	RC20GF224J	81349	3
R211	RESISTOR,FIXED,COMP.,39K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-393J	RC20GF393J	81349	1
R212	SAME AS R210			
R213	RESISTOR,FIXED,COMP.,47 OHMS,PORM 5 PCT,1/2W SINGER PART NO. 151-1003-470J	RC20GF470J	81349	1
R214 AND R215	RESISTOR,FIXED,COMP.,51K OHMS,PORM 5 PCT,1W SINGER PART NO. 151-1004-513J	RC32GF513J	81349	1
R216	RESISTOR,VARIABLE,25K OHMS,PORM 10 PCT,2W	151-0007-023	16665	1
R217	RESISTOR,FIXED,COMP.,62K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-623J	RC20GF623J	81349	1
R218 AND R424	RESISTOR,VARIABLE,DUAL,1 MEGOHM / 10K OHMS, PORM 10 PCT,2W	556057-006	16665	1
R219 AND R220	RESISTOR,FIXED,COMP.,510K OHMS,PORM 5 PCT,1W SINGER PART NO. 151-1004-514J	RC32GF514J	81349	1

TABLE V-6 PARTS LIST (SB-12bS)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
R221	SAME AS R208			
R222	RESISTOR,FIXED,COMP.,510K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-514J	RC20GF514J	81349	1
R223	RESISTOR,VARIABLE,50K OHMS,PORM 10 PCT,2W	151-0007-014	16665	1
R224	NOT USED			
R225	RESISTOR,FIXED,COMP.,40 OHMS,PORM 5 PCT,3W	151-2001-400J	16665	1
R226	SAME AS R113			
R227	RESISTOR,FIXED,COMP.,15K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-153J	RC20GF153J	81349	2
R228	RESISTOR,FIXED,COMP.,220 OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-221J	RC20GF221J	81349	2
R229	NOT USED			
R230	SAME AS R210			
R231	RESISTOR,FIXED,COMP.,12K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-123J	RC20GF123J	81349	2
R232 THRU R300	NOT USED			
R301	RESISTOR,FIXED,COMP.,6.2K OHMS,PORM 5 PCT 1/2W SINGER PART NO. 151-1003-622J	RC20GF622J	81349	1
R302	SAME AS R228			
R303	RESISTOR,FIXED,COMP.,430 OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-431J	RC20GF431J	81349	2
R304	RESISTOR,FIXED,COMP.,10K OHMS,PORM 5 PCT,2W SINGER PART NO. 151-1005-103J	RC42GF103J	81349	1
R305 AND R309	RESISTOR,VARIABLE,DUAL,2 MEG / 2 MEGOHMS,	556057-008	16665	1
R306	RESISTOR,FIXED,COMP.,2 MEGOHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-205J	RC20GF205J	81349	2
R307	SAME AS R303			
R308	SAME AS R228			
R309	SEE R305			
R310	RESISTOR,VARIABLE,5 MEGOHMS,PORM 10 PCT,2W	151-0007-004	16665	1
R311	RESISTOR,FIXED,COMP.,150 OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-151J	RC20GF151J	81349	1
R312	RESISTOR,VARIABLE,5K OHMS,PORM 10 PCT,2W	151-0001-014	16665	1
R313	RESISTOR,FIXED,COMP.,100K OHMS,PORM 5 PCT, 1W SINGER PART NO. 151-1004-104J	RC32GF104J	81349	2
R314	RESISTOR,FIXED,COMP.,75K OHMS,PORM 5 PCT,1W SINGER PART NO. 151-1004-753J	RC32GF753J	81349	2
R315	NOT USED			

TABLE V-6 PARTS LIST (SB-12bS)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
R316	RESISTOR,FIXED,COMP.,100K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-104J	RC20GF104J	81349	3
R317 AND R318	RESISTOR,FIXED,COMP.,100 OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-101J	RC20GF101J	81349	1
R319	RESISTOR,FIXED,COMP.,33K OHMS,PORM 5 PCT,1W SINGER PART NO. 151-1004-333J	RC32GF333J	81349	1
R320	SAME AS R201			
R321	SAME AS R223			
R322	SAME AS R109			
R323	RESISTOR,FIXED,COMP.,5.6K OHMS,PORM 5 PCT,1W SINGER PART NO. 151-1004-562J	RC32GF562J	81349	1
R324	RESISTOR,FIXED,COMP.,68K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-683J	RC20GF683J	81349	1
R325	SAME AS R203			
R326	RESISTOR,FIXED,COMP.,1K OHMS,PORM 5 PCT,1W SINGER PART NO. 151-1004-102J	RC32GF102J	81349	1
R327	SAME AS R227			
R328	SAME AS R314			
R329	SAME AS R313			
R330	SAME AS R311			
R331	SAME AS R304			
R332	SAME AS R316			
R333	RESISTOR,FIXED,COMP.,910 OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-911J	RC20GF911J	81349	1
R334	RESISTOR,FIXED,COMP.,6.8K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-682J	RC20GF682J	81349	2
R335	SAME AS R105			
R336	SAME AS R333			
R337	SAME AS R334			
R338	SAME AS R105			
R339 THRU R342	SAME AS R312			
R343	RESISTOR,FIXED,COMP. FACTORY SELECTED			
R344	RESISTOR,FIXED,COMP.,8.2K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-822J	RC20GF822J	81349	1
R345	SAME AS R303			
R346	RESISTOR,FIXED,COMP.,24K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-243J	RC20GF243J	81349	1
R347	SAME AS R115			

TABLE V-6 PARTS LIST (SB-12bS)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
R348	SAME AS R303			
R349	SAME AS R346			
R350	SAME AS R312			
R351	RESISTOR,FIXED,COMP.,22K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-223J	RC20GF223J	81349	1
R352	RESISTOR,FIXED,COMP.,47K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-473J	RC20GF473J	81349	1
R353	SAME AS R326			
R354	SAME AS R227			
R355	SAME AS R326			
R356	SAME AS R303			
R357	SAME AS R316			
R358	SAME AS R228			
R359	SAME AS R105			
R360	SAME AS R313			
R361	SAME AS R103			
R362	SAME AS R208			
R363	SAME AS R103			
R364	RESISTOR,FIXED,COMP.,5.6K OHMS,PORM 5 PCT 1/2W SINGER PART NO. 151-1003-562J	RC20GF562J	81349	1
R365	SAME AS R334			
R367	SAME AS R304			
R368	SAME AS R314			
R369	RESISTOR,FIXED,COMP.,390K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-394J	RC20GF394J	81349	1
R370 THRU R400	NOT USED			
R401	RESISTOR,FIXED,COMP.,120K OHMS,PORM 5 PCT,1W SINGER PART NO. 151-1004-124J	RC32GF124J	81349	1
R402	RESISTOR,FIXED,COMP.,33K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-333J	RC20GF333J	81349	1
R403	RESISTOR,FIXED,COMP.,1.5 MEGOHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-155J	RC20GF155J	81349	1
R404 AND R407	RESISTOR,VARIABLE,DUAL, 50K /5 MEGOHMS, PORM 10 PCT,2W	556057-007	16665	1
R405	SAME AS R352			
R406	SAME AS R203			
R407	SEE R404			

TABLE V-6 PARTS LIST (SB-12bS)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
R408	RESISTOR,FIXED,COMP.,200K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-204J	RC20GF204J	81349	1
R409	SAME AS R203			
R410 THRU R415	NOT USED			
R416	RESISTOR,FIXED,COMP.,750K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-754J	RC20GF754J	81349	1
R417	RESISTOR,FIXED,COMP.,56K OHMS,PORM 5 PCT,2W SINGER PART NO. 151-1005-563J	RC42GF563J	81349	1
R418	RESISTOR,FIXED,COMP.,240K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-244J	RC20GF244J	81349	1
R419 AND R420	NOT USED			
R421	SAME AS R310			
R422	RESISTOR,FIXED,COMP., FACTORY SELECTED			
R423	SAME AS R310			
R424	SEE R218			
R425	RESISTOR,FIXED,COMP,10 MEGOHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-106J	RC20GF106J	81349	1
R426	SAME AS R416			
R427	SAME AS R223			
R428	SAME AS R314			
R429	SAME AS R111			
R430	SAME AS R313			
R431	SAME AS R334			
R432	RESISTOR,FIXED,COMP.,1.8 MEGOHMS,PORM 5 PCT 1/2W SINGER PART NO. 151-1003-185J	RC20GF185J	81349	1
R433 THRU R435	SAME AS R210			
R436	SAME AS R306			
R437	SAME AS R316			
R438	NOT USED			
R439	RESISTOR,FIXED,COMP.,1.1 MEGOHMS,PORM 5 PCT 1/2W SINGER PART NO. 151-1003-115J	RC20GF115J	81349	1
R440 AND R441	SAME AS R115			
R442	SAME AS R227			
R443	SAME AS R231			
R444	SAME AS R351			

TABLE V-6 PARTS LIST (SB-12bS)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
R445 AND R446	NOT USED			
R447	SAME AS R222			
R448	RESISTOR,FIXED,COMP.,5.1 MEGOHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-515J	RC20GF515J	81349	1
R449	RESISTOR,VARIABLE,2 MEGOHMS,PORM 10 PCT,2W	151-0007-017	16665	1
R450	SAME AS R316			
R451	RESISTOR,FIXED,COMP.,15 OHMS,PORM 5 PCT,1/2W SINGER PART NO. 151-1003-150J	RC20GF150J	81349	1
R452	SAME AS R425			
R453	NOT USED			
R454	SAME AS R448			
R455	NOT USED			
R456	RESISTOR,VARIABLE,5 MEGOHMS,PORM 10 PCT,2W	151-0007-002	16665	1
R457	NOT USED			
R458	RESISTOR,FIXED,COMP.,470K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-474J	RC20GF474J	81349	1
R459 THRU R500	NOT USED			
R501	RESISTOR,FIXED,COMP.,120 OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-121J	RC20GF121J	81349	1
R502	RESISTOR,FIXED,COMP.,620 OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-621J	RC20GF621J	81349	1
R503	RESISTOR,FIXED,COMP,150K OHMS,PORM 5 PCT,1W SINGER PART NO. 151-1004-154J	RC32GF154J	81349	1
R504	SAME AS R210			
R505	SAME AS R313			
R506	RESISTOR,FIXED,COMP.,68K OHMS,PORM 5 PCT,1W SINGER PART NO. 151-1004-683J	RC32GF683J	81349	1
R507	RESISTOR,VARIABLE,500K OHMS,PORM 10 PCT,2W	151-0007-015	16665	1
R508	RESISTOR,FIXED,COMP., 1.2 MEGOHMS,PORM 5 PCT 1/2W SINGER PART NO. 151-1003-125J	RC20GF125J	81349	1
R509	SAME AS R210			
R510	SAME AS R364			
R511	SAME AS R313			
R512	RESISTOR,FIXED,COMP.,4.7K OHMS,PORM 5 PCT 1/2W SINGER PART NO. 151-1003-472J	RC20GF472J	81349	1
R513 THRU R514	NOT USED			

TABLE V-6 PARTS LIST (SB-12bS)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
R515	SAME AS R109			
R516	SAME AS R223			
R517	SAME AS R352			
R518	RESISTOR,FIXED,COMP.,390K OHMS,PORM 5 PCT,1W SINGER PART NO. 151-1004-394J	RC32GF394J	81349	1
R519	SAME AS R222			
R520	RESISTOR,VARIABLE,500K OHMS,2W SINGER PART NO. 556059-004	JA1N200P504UA	01121	1
R521	RESISTOR,FIXED,COMP.,270K OHMS,PORM 5 PCT,1W SINGER PART NO. 151-1004-274J	RC32GF274J	81349	1
R522	RESISTOR,VARIABLE,100K OHMS,2W SINGER PART NO. 556059-003	JA1N200P104UA	01121	1
R523	NOT USED			
R524	RESISTOR,FIXED,WIREWOUND,3.5K OHMS,PORM 5 PCT,2 W SINGER PART NO. 556047-004	20F3500WL	14841	1
R525	RESISTOR,VARIABLE,6 OHMS,2W WITH S501 ATTACHED SINGER PART NO. 556056-001	GC252	71450	1
R526	NOT USED			
R527	SAME AS R306			
R528	SAME AS R105			
R529 AND R530	RESISTOR,FIXED,COMP.,47K OHMS,PORM 5 PCT,2W SINGER PART NO. 151-1005-473J	RC42GF473J	81349	1
R531	NOT USED			
R532	SAME AS R306			
R533 THRU R700	NOT USED			
R701	RESISTOR,FIXED,COMP.,180K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-184J	RC20GF184J	81349	1
R702	RESISTOR,FIXED,COMP.,20K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-203J	RC20GF203J	81349	1
R703	SAME AS R103			
R704	SAME AS R701			
R705	RESISTOR,FIXED,COMP.,3.3K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-332J	RC20GF332J	81349	1
R706	NOT USED			
R707	RESISTOR,FIXED,COMP.,82K OHMS,PORM 5 PCT,2W SINGER PART NO. 151-1005-823J	RC42GF823J	81349	1
R708	RESISTOR,FIXED,PREC.,253 OHMS,PORM 1 PCT, 1/2W SINGER PART NO. 151-1008-B2530F	CI-2E2530HMPORM1PCT	12126	1
R709 AND R710	RESISTOR,FIXED,PREC.,62.3 PHMS,PORM 1 PCT 1/2W SINGER PART NO. 151-1008-B62R3F	CI-2E62R3OHMPORM1PCT	12126	1

TABLE V-6 PARTS LIST (SB-12bS)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
R711	RESISTOR,FIXED,PREC.,139 OHMS,PORM 1 PCT, 102W SINGER PART NO. 151-1008-B139OF	CI-2E139OHMPORM1PCT	12126	1
R712 AND R713	RESISTOR,FIXED,PREC.,72.8 PHMS,PORM 1 PCT, 1/2W SINGER PART NO. 151-1008-B72R8F	CI-2E72R8OHMPORM1PCT	12126	1
R714	RESISTOR,FIXED,PREC.,53.8 OHMS,PORM 1 PCT, 1/2W SINGER PART NO. 151-1008-B53R8F	CI-2E53R8OHMPORM1PCT	12126	1
R715 AND R716	RESISTOR,FIXED,PREC.,116.5 OHMS,PORM 1 PCT, 1/2W SINGER PART NO. 556029-341	CI-2E116R5OHM 1PCT	12126	1
R717	RESISTOR,FIXED,PREC.,24.3 OHMS,PORM 1 PCT, 1/2W SINGER PART NO. 151-1008-B24R3F	CI-2E24R3OHMPORM1PCT	12126	1
R718 AND R719	RESISTOR,FIXED,PREC.,226 OHMS,PORM 1 PCT 1/2W SINGER PART NO. 151-1008-B226OF	CI-2E226OHMPORM1PCT	12126	1
R720	RESISTOR,FIXED,PREC.,11.9 OHMS,PORM 1 PCT, 1/2W SINGER PART NO. 151-1008-B11R9F	CI-2E11R9OHMPORM1PCT	12126	1
R721 AND R722	RESISTOR,FIXED,PREC.,445 OHMS,PORM 1 PCT, 1/2W SINGER PART NO. 151-1008-B445OF	CI-2E445OHMPORM1PCT	12126	1
R723	RESISTOR,FIXED,PREC.,5.95 OHMS,PORM 1 PCT, 1/2W SINGER PART NO. 151-1008-B5R95OF	CI-2E5R9OHMPORM1PCT	12126	1
R724 AND R725	RESISTOR,FIXED,PREC.,887 OHMS,PORM 1 PCT, 1/2W SINGER PART NO. 151-1008-B887OF	CI-2E887OHMPORM1PCT	12126	1
R726	RESISTOR,VARIABLE,100K OHMS,PORM 10 PCT,2W	151-0007-025	16665	1
R727	SAME AS R312			
R728	NOT USED			
R729	RESISTOR,FIXED,COMP.,330K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-334J	RC20GF334J	81349	1
R730	NOT USED			
R731	RESISTOR,FIXED,COMP.,3.6K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-362J	RC20GF362J	81349	1
R732	NOT USED			
R733	SAME AS R731			
R734	NOT USED			
R735	SAME AS R729			
R736	NOT USED			
R737	SAME AS R231			
R738	NOT USED			
R739	SAME AS R231			
R740	NOT USED			
R741	SAME AS R707			
R742	NOT USED			

TABLE V-6 PARTS LIST (SB-12bS)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
R743	SAME AS R707			
R744	NOT USED			
R745	SAME AS R111			
R746	NOT USED			
R747	SAME AS R111			
R748	NOT USED			
R749	RESISTOR,FIXED,COMP.,180 OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-181J	RC20GF181J	81349	1
R750 THRU R800	NOT USED			
R801	SAME AS R334			
R802	NOT USED			
R803	SAME AS R334			
R804	NOT USED			
R805	RESISTOR,FIXED,COMP.,560 OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-561J	RC20GF561J	81349	1
R806	NOT USED			
R807	RESISTOR,VARIABLE,250 OHMS,PORM 10 PCT,2W	151-0001-009	16665	1
R808	NOT USED			
R809	SAME AS R402			
R810	NOT USED			
R811	SAME AS R402			
R812	NOT USED			
R813	SAME AS R316			
R814	NOT USED			
R815	SAME AS R213			
R816	NOT USED			
R817	SAME AS R208			
S200	NOT USED			
S201	SWITCH,TOGGLE,SPST SINGER PART NO. 556019-045	81015-AW	04009	1
S203 THRU S300	NOT USED			
S301	SWITCH,TOGGLE,DPDT SINGER PART NO. 556019-047	81027CE	04009	1
S302	SWITCH,TOGGLE,SPDT SINGER PART NO. 556019-068	81021AV	04009	1

TABLE V-6 PARTS LIST (SB-12bS)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
S303 THRU S401	NOT USED			
S402	SWITCH,ROTARY,10 POLE 6 POS. SINGER PART NO. 556019-201	PA12032	71590	1
S403	SWITCH,TOGGLE SINGER PART NO. 556163-866	203	82389	1
S404 THRU S501	NOT USED			
S502	SWITCH,TOGGLE,DPDT SINGER PART NO. 556019-067	8821K5	75382	1
S503 THRU S700	NOT USED			
S701 THRU S706	SWITCH,TOGGLE,DPDT SINGER PART NO. 556019-144	83054	04009	1
S707	SAME AS S502			
T100	NOT USED			
T101	TRANSFORMER	556026-422	16665	1
T102	TRANSFORMER	556026-085	16665	1
T103 THRU T400	NOT USED			
T401	TRANSFORMER,BTO	556020-096	16665	1
V1	ELECTRON TUBE SINGER PART NO. 556027-066	6AF4A	81349	1
V2	ELECTRON TUBE SINGER PART NO. 556027-135	6922	81349	1
V3	ELECTRON TUBE SINGER PART NO. 556027-082	6BE6	81349	1
V4	ELECTRON TUBE SINGER PART NO. 556027-067	6AH6	81349	1
V5	ELECTRON TUBE SINGER PART NO. 556027-086	6BH6	81349	2
V6	ELECTRON TUBE SINGER PART NO. 556027-016	12AL5	81349	1
V7 AND V8	ELECTRON TUBE SINGER PART NO. 556027-118	6U8A	81349	3
V9	ELECTRON TUBE SINGER PART NO. 556027-074	6AU6	81349	2
V10 AND V11	ELECTRON TUBE SINGER PART NO. 556027-020	12AU7	81349	4
V12	ELECTRON TUBE SINGER PART NO. 556027-037	5APD7	81349	1
V13	SAME AS V9			
V14	SAME AS V10			
V15	SAME AS V5			
V16	SAME AS V10			
V17	ELECTRON TUBE SINGER PART NO. 556027-048	5651	81349	1
V18	ELECTRON TUBE SINGER PART NO. 556027-003	OA2	81349	1

TABLE V-6 PARTS LIST (SB-12bS)

Ref Symbol		Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
V19		NOT USED			
V20		SAME AS V7			
XI1 XI5	THRU	SOCKET,LAMP SINGER PART NO. 556002-129	162-8430-9	72619	1
XQ1 XQ2	AND	SOCKET,TRANSISTOR SINGER PART NO. 556024-165	3304	91662	1
XQ3 XQ4	AND	SOCKET,TRANSISTOR SINGER PART NO 556024-161	8-A-12T	82893	1
XQ5 XQ6	AND	SAME AS XQ1			
XV1		SOCKET,TUBE SINGER PART NO. 556024-025	305 BC	91662	1
XV2		SOCKET,TUBE SINGER PART NO. 556024-166	TS103P03	81349	1
XV3 XV6	THRU	SAME AS XV1			
XV7 XV8	AND	SAME AS XV2			
XV9		SAME AS XV1			
XV10 XV11	AND	SAME AS XV2			
XV12		SOCKET,TUBE SINGER PART NO. 556024-324	3B14	71785	1
XV13 XV16	THRU	SAME AS XV2			
XV17 XV18	AND	SAME AS XV1			
XV19		NOT USED			
XV20		SAME AS XV2			
XY300		NOT USED			
XY301 XY303	THRU	SOCKET,CRYSTAL SINGER PART NO. 556024-017	33102	76487	1
XY304 XY700	THRU	NOT USED			
XY701		SAME AS XY301			
XY702 XY703	THRU	SOCKET,CRYSTAL SINGER PART NO. 556024-074	9006	72825	1
Y300		NOT USED			
Y301 Y302	AND	CRYSTAL,100 KC MATCHED PAIR	556025-052	16665	1
Y303		CRYSTAL,100 KC	556025-003	16665	1
Y304 Y700	THRU	NOT USED			

TABLE V-6 PARTS LIST (SB-12bS)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
Y701	CRYSTAL,500 5C SINGER PART NO. 556025-011	GW41	01875	1
Y702	CRYSTAL,3000 KC	556025-018	16665	1
Y703	CRYSTAL,3002 KC	556025-019	16665	1
Z100	NOT USED			
Z101	COIL,OSC.,600 KC	556026-086	16665	1
Z102	COIL,DISCRIMINATOR,600 KC	556026-270	16665	1
Z103	COIL,IF,100 KC	556026-200	16665	1
Z104	NOT USED			
Z105	COIL,IF,100 KC	556026-089	16665	1
	FUSE,DELAY,2 AMP SPARE FUSE FOR POWER SUPPLY SINGER PART NO. 556006-025	MDX-2	71400	

TABLE V-7 PARTS LIST (PS-12, PS-21)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
CR601 AND CR602	SEMICONDUCTOR DEVICE DIODE SINGER PART NO. 556118-005	V100HF	81483	1
C601	CAPACITOR,ELECTROLYTIC,2 X 20 UF,500 V, PLUG IN TYPE SINGER PART NO. 556070-007	QC2250	14655	1
C601	CAPACITOR,ELECTROLYTIC, 20 UF,500 V USED ON PS-12 ONLY SINGER PART NO. 556062-002	TVL1943	56289	1
C602	CAPACITOR,ELECTROLYTIC, 30 UF,500 V USED ON PS-12 ONLY SINGER PART NO. 556062-004	TVL1947	56289	1
C603	CAPACITOR,PAPER,OIL FILLED, 2 X 0.25 UF, 2500 V SINGER PART NO. 556115-002	7127-2X25	53021	1
C604	CAPACITOR,CERAMIC,0.01 UF,PLUS 80 PCT,MINUS 20 PCT,500 V SINGER PART NO. 556060-073	TYPE 811	72982	1
C605	CAPACITOR,PAPER,TUBULAR,0.1 UF,PORM 20 PCT, 400 V SINGER PART NO. 556120-019	330401	53021	1
C606	SAME AS C603			
C607 AND C608	CAPACITOR,AC LINE BYPASS,0.01,2000 V SINGER PART NO. 556060-095	TYPE 3878GP6-HIK	72982	1
F601 AND F602	FUSE,DELAY,2 AMP SINGER PART NO. 556006-025	MDX-2	71400	5
J601	CONNECTOR,FEMALE,14 CONTACTS SINGER PART NO. 556010-014	MS3102A28-2S	96906	1
J602	CONNECTOR,JACK BLACK SINGER PART NO. 556010-008	407	14655	1
J603	CONNECTOR,TWISTLOCK,3 WIRE SINGER PART NO. 556010-003	7486	74545	1
L601	COIL,8 HY	556012-120	16665	1
R601	RESISTOR,FIXED,COMP.,100K OHMS,PORM 5 PCT,1W SINGER PART NO. 151-1004-104J	RC32GF104J	81349	1
R602 AND R603	RESISTOR,FIXED,COMP.,10 MEGOHMS,PORM 5 PCT, 2W SINGER PART NO. 151-1005-106J	RC42GF106J	81349	1
R602 AND R603	RESISTOR,FIXED,COMP., 5.1 MEGOHM,PORM 5 PCT, 2W USED ON PS-12 ONLY SINGER PART NO. 151-1005-515J	RC42GF515J	81349	1
R605	RESISTOR,FIXED,COMP.,820K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-824J	RC20GF824J	81349	1
R606	RESISTOR,FIXED,COMP.,680K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-684J	RC20GF684J	81349	1
R607	RESISTOR,FIXED,COMP.,68K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-683J	RC20GF683J	81349	1
R608	RESISTOR,FIXED,COMP.,10K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-103J	RC20GF103J	81349	1
R609	RESISTOR,FIXED,COMP.,51K OHMS,PORM 5 PCT,1W SINGER PART NO. 151-1004-513J	RC32GF513J	81349	1

TABLE V-7 PARTS LIST (PS-12, PS-21)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
R610	RESISTOR,VARIABLE,10K OHMS,PORM 10 PCT,2W	151-0007-006	16665	1
R611	RESISTOR,FIXED,WIREWOUND,6K OHMS,5W SINGER PART NO. 556043-017	FRL5	94310	1
R612 AND R613	RESISTOR,FIXED,COMP.,470K OHMS,PORM 5 PCT,1W SINGER PART NO. 151-1004-474J	RC32GF474J	81349	1
R614	RESISTOR,FIXED,WIREWOUND,20K OHMS,PORM 10 PCT,1 W SINGER PART NO. 556045-028	FRL10	94310	1
R615	RESISTOR,FIXED,COMP.,1 MEGOHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-105J	RC20GF105J	81349	1
R616	RESISTOR,FIXED,COMP.,75K OHMS,PORM 10 PCT,1W SINGER PART NO. 151-1004-753J	RC32GF753K	81349	1
R617	RESISTOR,FIXED,COMP.,51 OHMS,PORM 5 PCT,1W SINGER PART NO. 151-1004-510J	RC32GF510J	81349	1
R619 AND R620	SAME AS R602 PS-21 ONLY			
T601	TRANSFORMER,LOW VOLTAGE	556020-150	16665	1
T602	TRANSFORMER,HIGH VOLTAGE	556020-146	16665	1
V101	ELECTRON TUBE SINGER PART NO. 556027-179	5V4G	81349	1
V102	ELECTRON TUBE SINGER PART NO. 556027-138	6AS7G	81349	1
V103	ELECTRON TUBE SINGER PART NO. 556027-022	12AX7	81349	1
V104	ELECTRON TUBE SINGER PART NO. 556027-048	5651	81349	1
XC601	SOCKET,TUBE SINGER PART NO. 556024-176	TS101P01	81349	1
XF601 AND XF602	HOLDER,FUSE SINGER PART NO. 556006-015	342003	75915	1
XV101 AND XV102	SAME AS XC601			
XV103	SOCKET,TUBE SINGER PART NO. 556024-166	TS103P03	81349	1
XV104	SOCKET,TUBE SINGER PART NO.167-0001-005	4-715-02	91662	1

TABLE V-8 PARTS LIST (RF-7a)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
	VARIABLE FREQUENCY OSCILLATOR SINGER PART NO. 556014-934	481AVFO	11190	1
CR1	SEMICONDUCTOR DEVICE,DIODE SINGER PART NO. 556118-041	1N34A	86684	1
CR2 THRU CR5	SEMICONDUCTOR DEVICE,DIODE SINGER PART NO. 556118-075	1N1084	84970	1
CR6 AND CR7	SEMICONDUCTOR DEVICE,DIODE SINGER PART NO. 556118-076	10LA	84970	1
CR8	SEMICONDUCTOR DEVICE,DIODE SINGER PART NO. 556118-077	1Z5-8T5	04713	1
C1	CAPACITOR,CERAMIC, 10000 PF,GMV,600V. SINGER PART NO. 556076-041	B10000	91418	1
C2	CAPACITOR,VARIABLE, 2.3 TO 14.2 PF SINGER PART NO. 556076-042	15M11	74970	1
C3	CAPACITOR,VARIABLE, 10.5 TO 16.2 PF SINGER PART NO. 556076-043	821119	77630	1
C4	NOT USED			
C5	CAPACITOR,CERAMIC, 1000 PF,PORM 10 PCT,600V SINGER PART NO. 556076-047	JL001	91418	1
C6	CAPACITOR,CERAMIC, 250 PF,PORM 10 PCT,600V SINGER PART NO. 556076-046	JL250	91418	1
C7	CAPACITOR,CERAMIC, 10000 PF,PLUS 80 PCT, MINUS 20 PCT,100V SINGER PART NO. 556076-045	BT-.01	91418	1
C8	SAME AS C1			
C9	SAME AS C2			
C10	SAME AS C5			
C11	SAME AS C6			
C12	SAME AS C7			
C13	SAME AS C1			
C14	SAME AS C2			
C15	CAPACITOR,CERAMIC, 1000 PF,GMV,600V	B1000	91418	2
C16	SAME AS C6			
C17	SAME AS C7			
C18	SAME AS C5			
C19	SAME AS C2			
C20	SAME AS C15			
C21	SAME AS C1			
C22	CAPACITOR,ELECTROLYTIC,DUAL, 20 UF,450V SINGER PART NO. 556076-048	AEP44J	00656	1

TABLE V-8 PARTS LIST (RF-7a)

Ref Symbol		Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
C23		CAPACITOR,CERAMIC, 40000PF,PLUS 80 PCT, MINUS 20 PCT,600V SINGER PART NO. 556076-050	TYPE B	91418	1
C24		CAPACITOR,ELECTROLYTIC, 2000 UF,15V SINGER PART NO. 556076-051	AEP400P	00656	1
C25		CAPACITOR,CERAMIC, 15 PF,PORM 10 PCT,600V SINGER PART NO. 556076-052	TYPE C15	91418	1
C26		SAME AS C15			
C27		SAME AS C1			
C28		SAME AS C15			
C29		SAME AS C1			
C30		SAME AS C15			
C31		SAME AS C1			
C32		SAME AS C15			
C33		CAPACITOR,MICA, 500 PF,PORM 10 PCT,500V SINGER PART NO. 556076-053	J1HF	92364	1
C34		CAPACITOR,CERAMIC, 47 PF,PORM 10 PCT,600V	TYPE JL	91418	1
C35 C36	AND	CAPACITOR,CERAMIC,10000 PF,GMV,1400V	TYPE U	91418	1
C37		SAME AS C33			
C38		SAME AS C7			
DS1 DS2	AND	LAMP,INCANDESCENT, 12V SINGER PART NO. 556001-259	1813	24455	3
DS3		LAMP,INCANDESCENT SINGER PART NO. 556144-300	328	24455	3
F1		FUSE,CARTRIDGE, 3/4 AMP SINGER PART NO. 556012-133	AGC3-4	98977	5
J1 J3	THRU	JACK,PIN SINGER PART NO. 556144-302	110BCS	01009	1
J4		CONNECTOR,RECEPTACLE SINGER PART NO. 556144-303	UG1094/U	81349	1
L1		COIL,RF SINGER PART NO. 556012-127	A547015	11190	1
L2		COIL,RF SINGER PART NO. 556012-128	A547027	11190	1
L3		COIL,RF SINGER PART NO. 556012-129	A547022	11190	1
L4		COIL,RF SINGER PART NO. 556012-130	A547026	11190	1
L5		CHOKE,RF, 240 UH SINGER PART NO. 556012-131	3240-15	99848	1
L6 L7	AND	CHOKE,FILTER SINGER PART NO. 556012-132	AP19001	11190	1
L8		CHOKE,RF, 38 UH SINGER PART NO. 556144-305	3038-15	99848	1

TABLE V-8 PARTS LIST (RF-7a)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
M1	METER SPECIAL SINGER PART NO. 556013-020	A547018	11190	1
P1	CONNECTOR,FEMALE SINGER PART NO. 556144-307	149192	92294	1
R1	RESISTOR,FIXED,COMP., 100K OHMS,PORM 10 PCT, 1/2W SINGER PART NO. 151-1003-104K	RC20GF104K	81349	1
R2	RESISTOR,FIXED,COMP., 68 OHMS,PORM 10 PCT, 1/2W SINGER PART NO. 151-1003-680K	RC20GF680K	81349	2
R3	RESISTOR,FIXED,COMP., 15K OHMS,PORM 10 PCT, 1W SINGER PART NO. 151-1004-153K	RC32GF153K	81349	1
R4	RESISTOR,FIXED,COMP., 4.7K OHMS,PORM 10 PCT, 1W SINGER PART NO. 151-1004-472K	RC32GF472K	81349	3
R5	RESISTOR,VARIABLE, 20K OHMS,2W SINGER PART NO. 556034-183	R20ML	90201	1
R6	SAME AS R1			
R7	RESISTOR,FIXED,COMP., 10K OHMS,PORM 10 PCT, 1/2W SINGER PART NO. 151-1003-103K	RC20GF103K	81349	2
R8	SAME AS R2			
R9	SAME AS R3			
R10	SAME AS R4			
R11	RESISTOR,FIXED,COMP., 22K OHMS,PORM 10 PCT, 1/2W SINGER PART NO. 151-1003-223K	RC20GF223K	81349	1
R12	SAME AS R7			
R13	SAME AS R2			
R14	RESISTOR,FIXED,COMP., 10K OHMS,PORM 10 PCT, 1W SINGER PART NO. 151-1004-103K	RC32GF103K	81349	1
R15	SAME AS R4			
R16	SAME AS R1			
R17	SAME AS R2			
R18	SAME AS R7			
R19	SAME AS R4			
R20	SAME AS R4			
R21	RESISTOR,WIREWOUND, 2.5K,5W SINGER PART NO. 556040-005	1540	44655	1
R22	NOT USED			
R23	RESISTOR,WIREWOUND, 2K OHMS,5W	1538	44655	1
R24 THRU R26	RESISTOR,FIXED,COMP., 18 OHMS,PORM 10 PCT,1W SINGER PART NO. 151-1004-180K	RC32GF180K	81349	1
R27	NOT USED			
R28	RESISTOR,VARIABLE, 3 OHMS,25W SINGER PART NO. 556034-182	361	44655	1

TABLE V-8 PARTS LIST (RF-7a)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
R29	NOT USED			
R30	SAME AS R4			
S1	SWITCH,ROTARY SINGER PART NO. 556019-250	97311N3C	76854	1
S2	SWITCH,TOGGLE, SPST SINGER PART NO. 556019-251	US30	90201	1
T1	TRANSFORMER,POWER SINGER PART NO. 556020-082	AP16019	11190	1
V1 THRU V3	ELECTRON TUBE SINGER PART NO. 556027-074	6AU6	81349	3
V4	ELECTRON TUBE SINGER PART NO. 556027-067	6AH6	81349	1
V5	ELECTRON TUBE SINGER PART NO. 556027-007	0B2	81349	1
W1	CABLE ASSY WITH P2 ATTACHED SINGER PART NO. 556023-254	1609-1-3101-0-100L	71700	1
XC22	SOCKET,CAPACITOR SINGER PART NO. 556024-343	101-24-11-057	71785	1
XC23	NOT USED			
XC24	SAME AS XC22			
XDS1 AND XDS2	SOCKET,LAMP SINGER PART NO. 556002-442	1925	83330	1
XDS3	SOCKET,LAMP SINGER PART NO. 556002-441	101-5030-972	75915	1
XF1	SOCKET,FUSE SINGER PART NO. 556006-013	342003	75915	1
XV1 THRU XV5	SOCKET,TUBE SINGER PART NO. 556024-219	4-703-02	91662	1

TABLE V-9 PARTS LIST (TTG-2)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
AT301	ATTENUATOR,VARIABLE DECADE,0 - 100 DB SINGER PART NO. 556001-317	HA710	83322	1
AT302	NOT USED			
AT303	ATTENUATOR,VARIABLE DECADE,0 - 10 DB SINGER PART NO. 556001-318	HA711	83332	1
CR401	SEMICONDUCTOR DEVICE DIODE SINGER PART NO. 556118-018	IN2389	84970	1
C100	NOT USED			
C101	CAPACITOR,ELECTROLYTIC, 40 UF,450 V SINGER PART NO. 556070-008	PE2764	80183	1
C102	NOT USED			
C103	CAPACITOR,ELECTROLYTIC, 10 UF,150 V SINGER PART NO. 556074-003	BR1015	14655	1
C104	NOT USED			
C105	CAPACITOR,ELECTROLYTIC, 20 UF,250 V SINGER PART NO. 556073-002	BR1015	14655	1
C106	NOT USED			
C107	CAPACITOR,ELECTROLYTIC, 50 UF,50 V SINGER PART NO. 556073-004	TE1307	80183	1
C108	NOT USED			
C109	CAPACITOR,MICA FACTORY SELECTED			
C110	NOT USED			
C111	CAPACITOR,MICA, 0.04 UF,PORM 5 PCT,100V SINGER PART NO. 556098-010	1AD1S40JF	14655	1
C112	CAPACITOR,MICA, 6800 PF,PORM 5 PCT,500 V SINGER PART NO. 556098-002	1A5D68	14655	1
C113	CAPACITOR,MICA, 4700 PF,PORM 5 PCT,500 V SINGER PART NO. 556098-004	1A5D47	14655	1
C114	NOT USED			
C115	CAPACITOR,MICA FACTORY SELECTED			
C116	NOT USED			
C117	CAPACITOR,MICA, 470 PF,PORM 5 PCT,500 V SINGER PART NO. 556098-005	22A5T47	14655	1
C118	NOT USED			
C119	CAPACITOR,VARIABLE, 7 TO 45 PF SINGER PART NO. 556122-059	822-125	71590	1
C120	NOT USED			
C121	CAPACITOR,VARIABLE,DUAL, 10 PF TO 100 PF	556123-002	16665	1
C122	NOT USED			

TABLE V-9 PARTS LIST (TTG-2)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
C123	SAME AS C121			
C124 THRU C202	NOT USED			
C203	SAME AS C103			
C204	NOT USED			
C205	SAME AS C105			
C206	NOT USED			
C207	SAME AS C107			
C208	NOT USED			
C209	SAME AS C109			
C210	NOT USED			
C211	SAME AS C111			
C212	SAME AS C112			
C213	SAME AS C113			
C214	NOT USED			
C215	SAME AS C115			
C216	NOT USED			
C217	SAME AS C117			
C218	NOT USED			
C219	SAME AS C119			
C220	NOT USED			
C221	SAME AS C121			
C222	NOT USED			
C223	SAME AS C121			
C224 THRU C300	NOT USED			
C301	CAPACITOR,MICA, 1500 PF,PORM 5 PCT SINGER PART NO. 556081-009	CM20E152J	81349	1
C302 THRU C400	NOT USED			
C401	SAME AS C101			
DS400	NOT USED			
DS401	LAMP,INCANDESCENT SINGER PART NO. 160-6001-002	349	08806	3
F400	NOT USED			
F401	FUSE,DELAY,1 AMP SINGER PART NO.556006-017	313001	75915	5

TABLE V-9 PARTS LIST (TTG-2)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
I100	NOT USED			
I101	LAMP,INCANDESCENT SINGER PART NO. 556002-094	3S6	08806	6
I102 THRU I200	NOT USED			
I201	SAME AS I101			
J300	NOT USED			
J301	CONNECTOR,BINDING POST,BLACK SINGER PART NO. 556010-04U	111-103	74970	1
J302 AND J303	CONNECTOR,BINDING POST,RED SINGER PART NO. 556010-066	111-102	74970	1
M300	NOT USED			
M301	METER,0-5 V	556013-004	16665	1
P400	NOT USED			
P401	CORD,LINE WITH PLUG ATTACHED	556161-212	16665	1
R100	NOT USED			
R101	RESISTOR,FIXED,PREC. 100K OHMS,PORM 1 PCT,1W SINGER PART NO. 151-1009-B1003F	CIE100000HMPORM1PCT	12126	1
R102	NOT USED			
R103	SAME AS R101			
R104	NOT USED			
R105	RESISTOR,FIXED,PREC.,50K OHMS,PORM 1 PCT,1W SINGER PART NO. 151-1009-B5002F	CIE500000HMPORM1PCT	12126	1
R106	NOT USED			
R107	SAME AS R105			
R108	NOT USED			
R109	RESISTOR,FIXED,PREC. 33.3K OHMS,PORM 1 PCT, 1W SINGER PART NO. 151-1009-B3332F	CIE333000HMPORM1PCT	12126	2
R110	NOT USED			
R111	SAME AS R109			
R112	NOT USED			
R113	RESISTOR,FIXED,PREC. 25K OHMS,PORM 1 PCT,1W SINGER PART NO. 151-1009-B2502F	CIE250000HMPORM1PCT	12126	2
R114	NOT USED			
R115	SAME AS R113			
R116	NOT USED			
R117	RESISTOR,FIXED,PREC. 1 MEGOHM,PORM 1 PCT,UW SINGER PART NO. 151-1009-B1004F	CIE1MEGOHMPORM1PCT	12126	2

TABLE V-9 PARTS LIST (TTG-2)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
R118	NOT USED			
R119	SAME AS R117			
R120	NOT USED			
R121	RESISTOR,FIXED,PREC. 500K OHMS,PORM 1 PCT,1W SINGER PART NO. 151-1009-5003F	CIE5000000HMPORM1PCT	12126	2
R122	NOT USED			
R123	SAME AS R121			
R124	NOT USED			
R125	RESISTOR,FIXED,PREC. 330K OHMS,PORM 1 PCT,1W SINGER PART NO. 151-1009-B3303F	CIE3300000HMPORM1PCT	12126	2
R126	NOT USED			
R127	SAME AS R125			
R128	NOT USED			
R129	RESISTOR,FIXED,PREC. 250K OHMS,PORM 1 PCT,1W SINGER PART NO. 151-1009-B2503F	CIE2500000HMPORM1PCT	12126	2
R130	NOT USED			
R131	SAME AS R129			
R132	NOT USED			
R133	RESISTOR,FIXED,PREC. 10 MEGOHMS,PORM 1 PCT, 1W SINGER PART NO. 151-1009-B1005F	CIE10MEGOHMPORM1PCT	12126	2
R134	NOT USED			
R135	SAME AS R133			
R136	NOT USED			
R137	RESISTOR,FIXED,PREC. 5 MEGOHMS,PORM 1 PCT,1W SINGER PART NO. 151-1009-B5004F	CIE5MEGOHMPORM1PCT	12126	2
R138	NOT USED			
R139	SAME AS R137			
R140	NOT USED			
R141	RESISTOR,FIXED,&REC. 3.33 MEGOHMS,PORM 1 PCT 1W SINGER PART NO. 151-1009-B3334	CIE3R33MEGOHM-1PCT	12126	2
R142	NOT USED			
R143	SAME AS R141			
R144	NOT USED			
R145	RESISTOR,FIXED,PREC. 2.5 MEGOHMS,PORM 1 PCT, 1W SINGER PART NO. 151-1009-B2504F	CIE2R5MEGOHMPORM1PCT	12126	2
R146	NOT USED			
R147	SAME AS R145			

TABLE V-9 PARTS LIST (TTG-2)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
R148	NOT USED			
R149	RESISTOR,FIXED,COMP., 47K OHMS,PORM 5 PCT,2W SINGER PART NO. 151-1005-473J	RC42GF473J	81349	2
R150	NOT USED			
R151	RESISTOR,VARIABLE, 100K OHMS,PORM 10 PCT, 1/2W	151-0001-018	16665	1
R152	NOT USED			
R153	RESISTOR,FIXED,COMP., 1K OHMS,PORM 5 PCT,2W SINGER PART NO. 151-1005-102J	RC42GF102J	81349	1
R154	NOT USED			
R155	RESISTOR,FIXED,COMP., 36K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-363J	RC20GF363J	81349	1
R156	NOT USED			
R157	SAME AS R149			
R158	NOT USED			
R159	RESISTOR,FIXED,COMP., 330 OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-331J	RC20GF331J	81349	1
R160	NOT USED			
R161	RESISTOR,FIXED,COMP., 47 OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-470J	RC20GF470J	81349	1
R162	NOT USED			
R163	RESISTOR,FIXED,WIRE WOUND, 5K,25W SINGER PART NO. 556048-002	20F5000WL	75042	1
R164	NOT USED			
R165	RESISTOR,VARIABLE, 500 OHMS,PORM 10 PCT,2W	151-0007-009	16665	1
R166	NOT USED			
R167	RESISTOR,VARIABLE, 300 OHMS,PORM 10 PCT,2W	151-0007-005	16665	1
R168	NOT USED			
R169	RESISTOR,VARIABLE, 1K OHMS,PORM 10 PCT,2W	151-0007-018	16665	1
R170 THRU R200	NOT USED			
R201	SAME AS R101			
R202	NOT USED			
R203	SAME AS R101			
R204	NOT USED			
R205	SAME AS R105			
R206	NOT USED			

TABLE V-9 PARTS LIST (TTG-2)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
R207	SAME AS R105			
R208	NOT USED			
R209	SAME AS R109			
R210	NOT USED			
R211	SAME AS R109			
R212	NOT USED			
R213	SAME AS R113			
R214	NOT USED			
R215	SAME AS R113			
R216	NOT USED			
R217	SAME AS R117			
R218	NOT USED			
R219	SAME AS R117			
R220	NOT USED			
R221	SAME AS R121			
R222	NOT USED			
R223	SAME AS R121			
R224	NOT USED			
R225	SAME AS R125			
R226	NOT USED			
R227	SAME AS R125			
R228	NOT USED			
R229	SAME AS R129			
R230	NOT USED			
R231	SAME AS R129			
R232	NOT USED			
R233	SAME AS R130			
R234	NOT USED			
R235	SAME AS R133			
R236	NOT USED			
R237	SAME AS R137			
R238	NOT USED			
R239	SAME AS R137			

TABLE V-9 PARTS LIST (TTG-2)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
R240	NOT USED			
R241	SAME AS R141			
R242	NOT USED			
R243	SAME AS R141			
R244	NOT USED			
R245	SAME AS R145			
R246	NOT USED			
R247	SAME AS R145			
R248	NOT USED			
R249	SAME AS R149			
R250	NOT USED			
R251	SAME AS R151			
R252	NOT USED			
R253	SAME AS R153			
R254	NOT USED			
R255	SAME AS R155			
R256	NOT USED			
R257	SAME AS R149			
R258	NOT USED			
R259	SAME AS R159			
R260	NOT USED			
R261	SAME AS R161			
R262	NOT USED			
R263	SAME AS R160			
R264	NOT USED			
R265	SAME AS R165			
R266	NOT USED			
R267	SAME AS R167			
R268	NOT USED			
R269	SAME AS R169			
R270 THRU R300	NOT USED			
R301	RESISTOR,FIXED,PREC.,600 OHMS,PORM 1 PCT,1W SINGER PART NO. 151-1009-B0601F	CIE600OHMPORM1PCT	12126	1

TABLE V-9 PARTS LIST (TTG-2)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
R302	NOT USED			
R303	RESISTOR,FIXED,COMP., 390 OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-391J	RC20GF391J	81349	1
R304	NOT USED			
R305	RESISTOR,VARIABLE, 300 OHMS,PORM 10 PCT,2W	151-0007-008	16665	1
R306 THRU R308	NOT USED			
R309	RESISTOR,FIXED,COMP., 300 OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-301J	RC20GF301J	81349	1
R310	NOT USED			
R311	SAME AS R311			
R312 THRU R400	NOT USED			
R401	RESISTOR,FIXED,WIREWOUND, 750 OHMS,PORM 5 PCT,25W SINGER PART NO. 556048-001	203	44655	1
R402	NOT USED			
R403	RESISTOR,FIXED,COMP., 220K OHMS,PORM 5 PCT, 1W SINGER PART NO. 151-1004-224J	RC32GF224J	81349	1
R404	NOT USED			
R405	RESISTOR,FIXED,COMP., 68K OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-683J	RC20GF683J	81349	1
R406	NOT USED			
R407	RESISTOR,FIXED,COMP., 10 OHMS,PORM 5 PCT, 1/2W SINGER PART NO. 151-1003-100J	RC20GF100J	81349	1
S100	NOT USED			
S101	SWITCH,ROTARY	556019-237	16665	1
S102	SWITCH,ROTARY	556019-236	16665	1
S103	SAME AS S102			
S104	SWITCH,ROTARY	556019-235	16665	1
S105 THRU S200	NOT USED			
S201	SAME AS S101			
S202 AND S203	SAME AS S102			
S204	SAME AS S104			
S205 THRU S300	NOT USED			
S301	SWITCH,TOGGLE,DPST SINGER PART NO. 556019-106	316B73	73559	1

TABLE V-9 PARTS LIST (TTG-2)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
S302 THRU S308	NOT USED			
S309	SWITCH,ROTARY	556019-238	16665	1
S310 THRU S400	NOT USED			
S401	SAME AS S301			
T300	NOT USED			
T301	TRANSFORMER SINGER PART NO. 556020-072	LS141	80223	1
T302 THRU T400	NOT USED			
T401	TRANSFORMER,POWER SINGER PART NO. 556020-073	PHC85	80183	1
V100	NOT USED			
V101	ELECTRON TUBE SINGER PART NO. 556027-074	6AU6	81349	2
V102	ELECTRON TUBE SINGER PART NO. 556027-096	6CL6	81349	2
V103 THRU V200	NOT USED			
V201	SAME AS V101			
V202	SAME AS V102			
XC100	NOT USED			
XC101	SOCKET,TUBE SINGER PART NO. 556024-176	TS101P02	81349	1
XC102 THRU XC400	NOT USED			
XC401	SAME AS XC101			
XDS400	NOT USED			
XDS401	SOCKET,PILOT LIGHT SINGER PART NO. 556002-129	1628430-972	72619	1
XF400	NOT USED			
XF401	HOLDER,FUSE SINGER PART NO. 556006-015	342004	75382	1
XI100	NOT USED			
XI101	SOCKET,LAMP SINGER PART NO. 556002-113	5038	75382	1
XI103 THRU XI200	NOT USED			
XI201	SAME AS XI101			
XV100	NOT USED			
XV101	SOCKET,TUBE SINGER PART NO. 167-0001-005	TS101P02	81349	1
XV102	SOCKET,TUBE SINGER PART NO. 556024-166	TS103P02	81349	1

TABLE V-9 PARTS LIST (TTG-2)

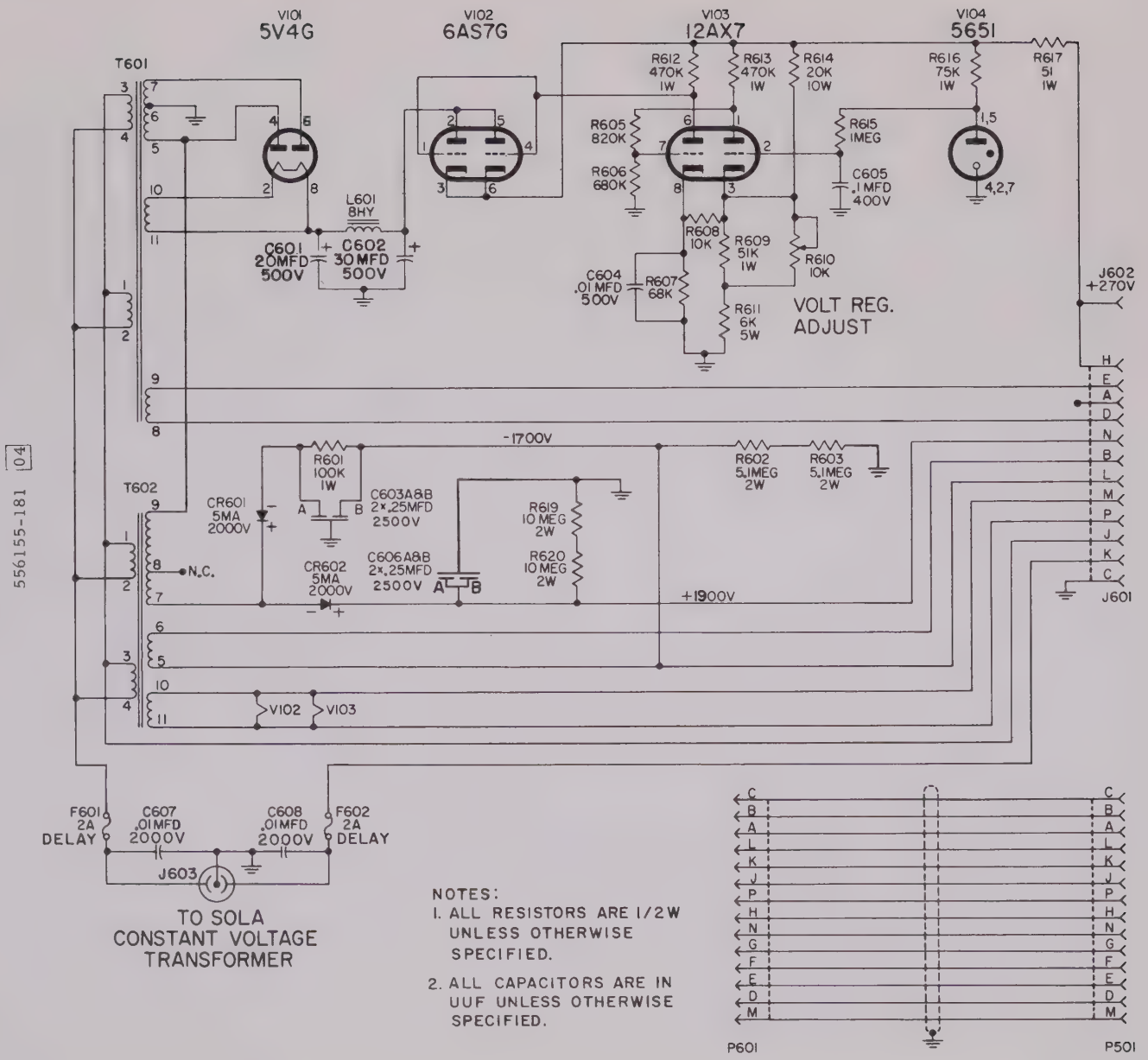
Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
XV103 THRU XV200	NOT USED			
XV201	SAME AS XV101			
XV202	SAME AS XV102			

TABLE V-10 PARTS LIST (PRB-2)

Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
	CATHODE FOLLOWER PROBE	101-0066-002	16665	
P3	CONNECTOR,PLUG SINGER PART NO. 556010-004	83-1R	02660	
P4	CONNECTOR,PLUG SINGER PART NO. 168-0001-002	MS3108B14S5P	96906	
	ATTENUATOR,FIXED, 20 DB SINGER PART NO. 556001-071	PAX1	80009	
	ATTENUATOR,FIXED, 40 DB SINGER PART NO. 556001-072	PAX2	80009	
	ATTENUATOR,FIXED, 60 DB SINGER PART NO. 556001-073	PAX3	80009	
	TIP,PROBE,HOOKED SINGER PART NO. 556005-031	206008	80009	
	TIP,PROBE,POINTED SINGER PART NO. 556005-030	206009	80009	
	TIP,PROBE,ALLIGATOR CLIP SINGER PART NO. 556005-032	344005	80009	

TABLE V-11 PARTS LIST (ACCESSORY)

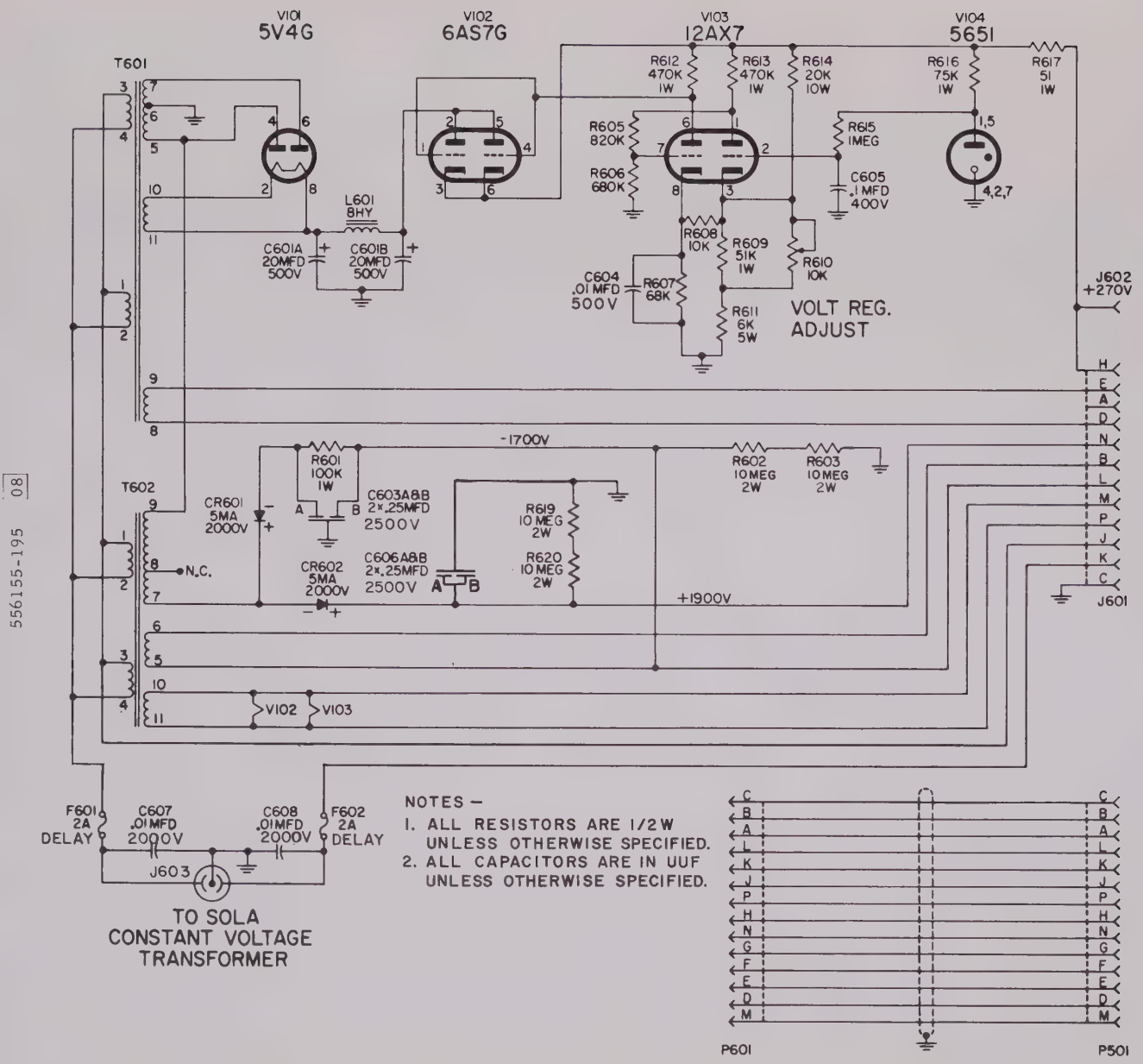
Ref Symbol	Description	Manufacturer's Part Number	Mfr's Code	Maint Qty
P501	CONNECTOR,PLUG PART OF 556161-319 CABLE, ASSY SINGER PART NO. 556010-015	MS3108B28-2S	96906	
P601	CONNECTOR,PLUG PART OF 556161-319 CABLE, ASSY SINGER PART NO. 556016-044	MS3106B28-2P	96906	
	TRANSFORMER,REGULATING, 50 CPS, 220 VAC SELECT AS REQUIRED	556020-046	16665	
	TRANSFORMER,REGULATING, 50 CPS, 115 VAC SELECT AS REQUIRED	556020-064	16665	
	TRANSFORMER,REGULATING, 60 CPS, 115 VAC SELECT AS REQUIRED	556020-162	16665	
	CABLE ASSY POWER	556161-319	16665	
	CABLE ASSY INTERCONNECTING	556161-326	16665	
	CABLE ASSY COAXIAL	556161-036	16665	
	LINE CORD AC	556161-066	16665	
	ADAPTER,CONNECTOR SINGER PART NO. 556010-230	228	71700	



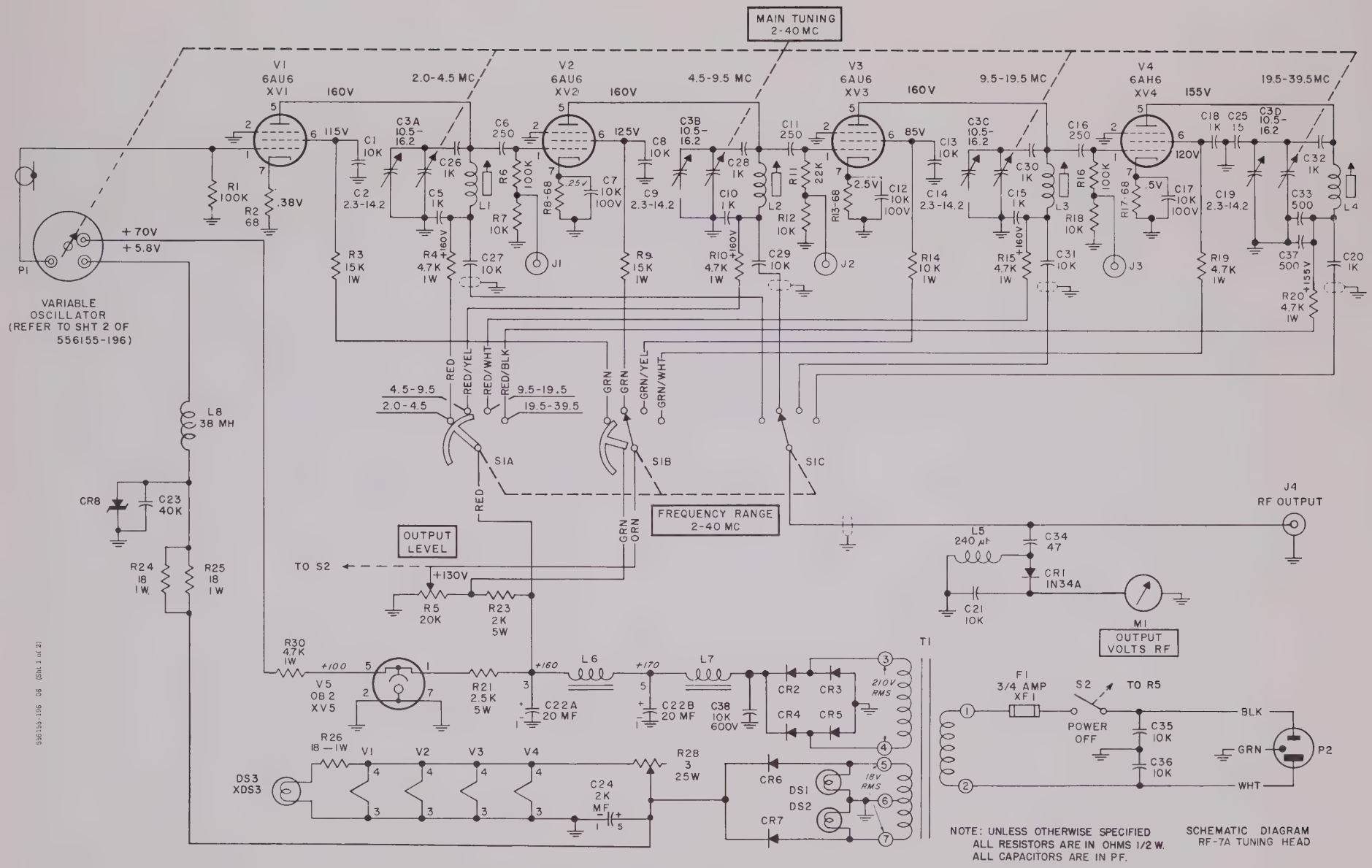
NOTES:

1. ALL RESISTORS ARE 1/2W UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS ARE IN UUF UNLESS OTHERWISE SPECIFIED.

PS-12, Power Supply Schematic



PS-21, Power Supply Schematic

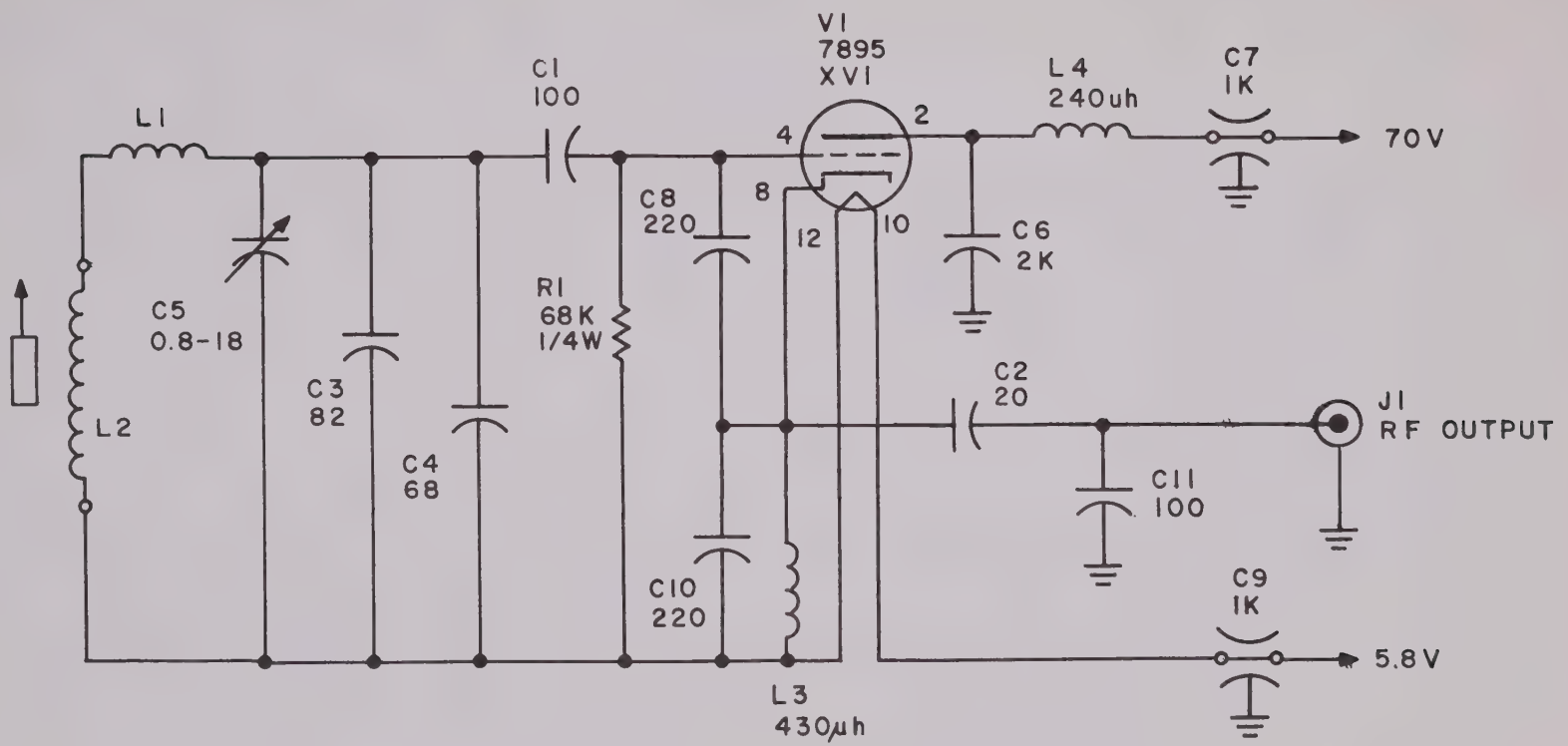


NOTE: UNLESS OTHERWISE SPECIFIED
ALL RESISTORS ARE IN OHMS 1/2 W.
ALL CAPACITORS ARE IN P.F.

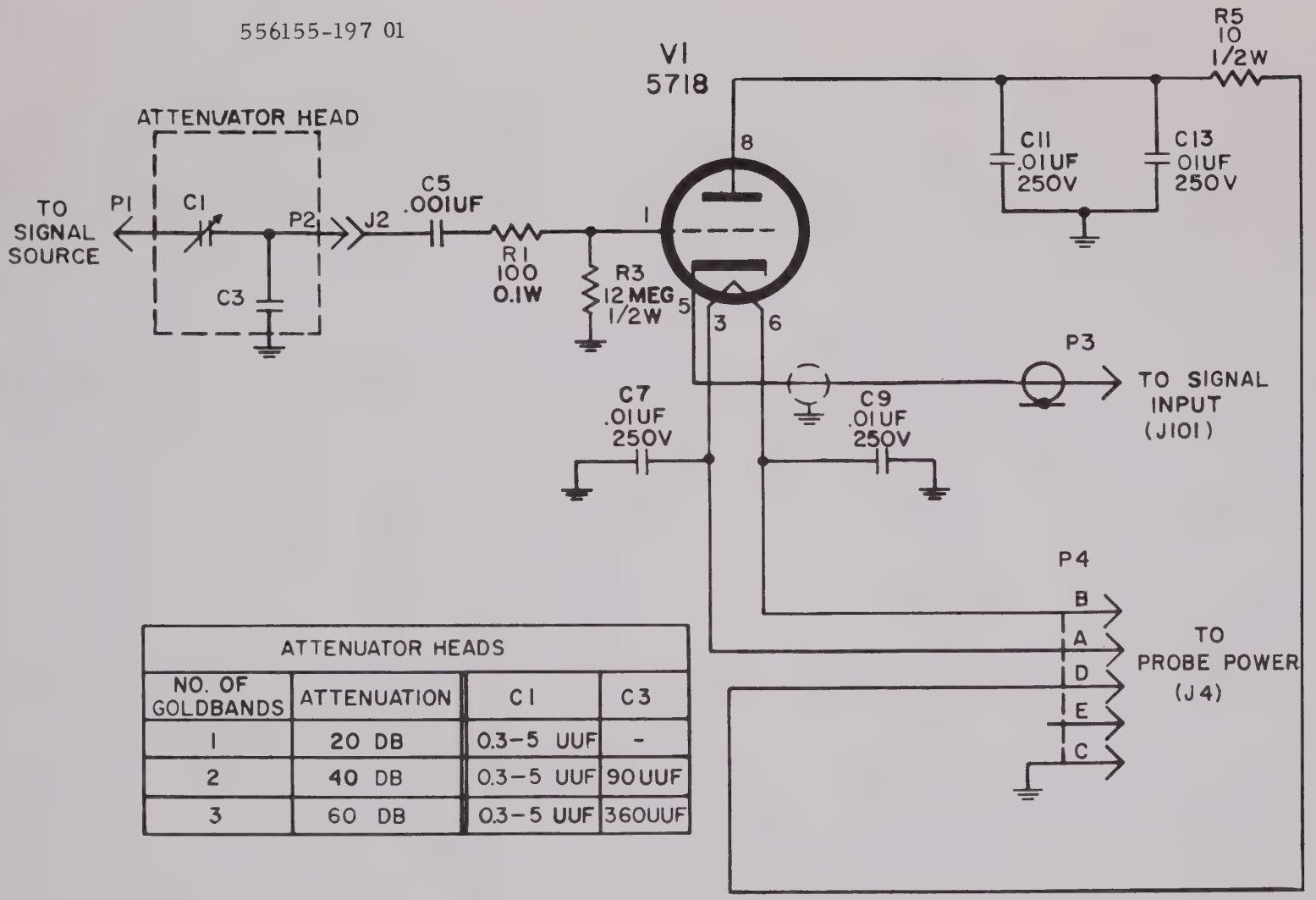
SCHEMATIC DIAGRAM
RF-7A TUNING HEAD

RF-7a, Tuning Head Schematic

556155-196 06 (Sht 2 of 2)



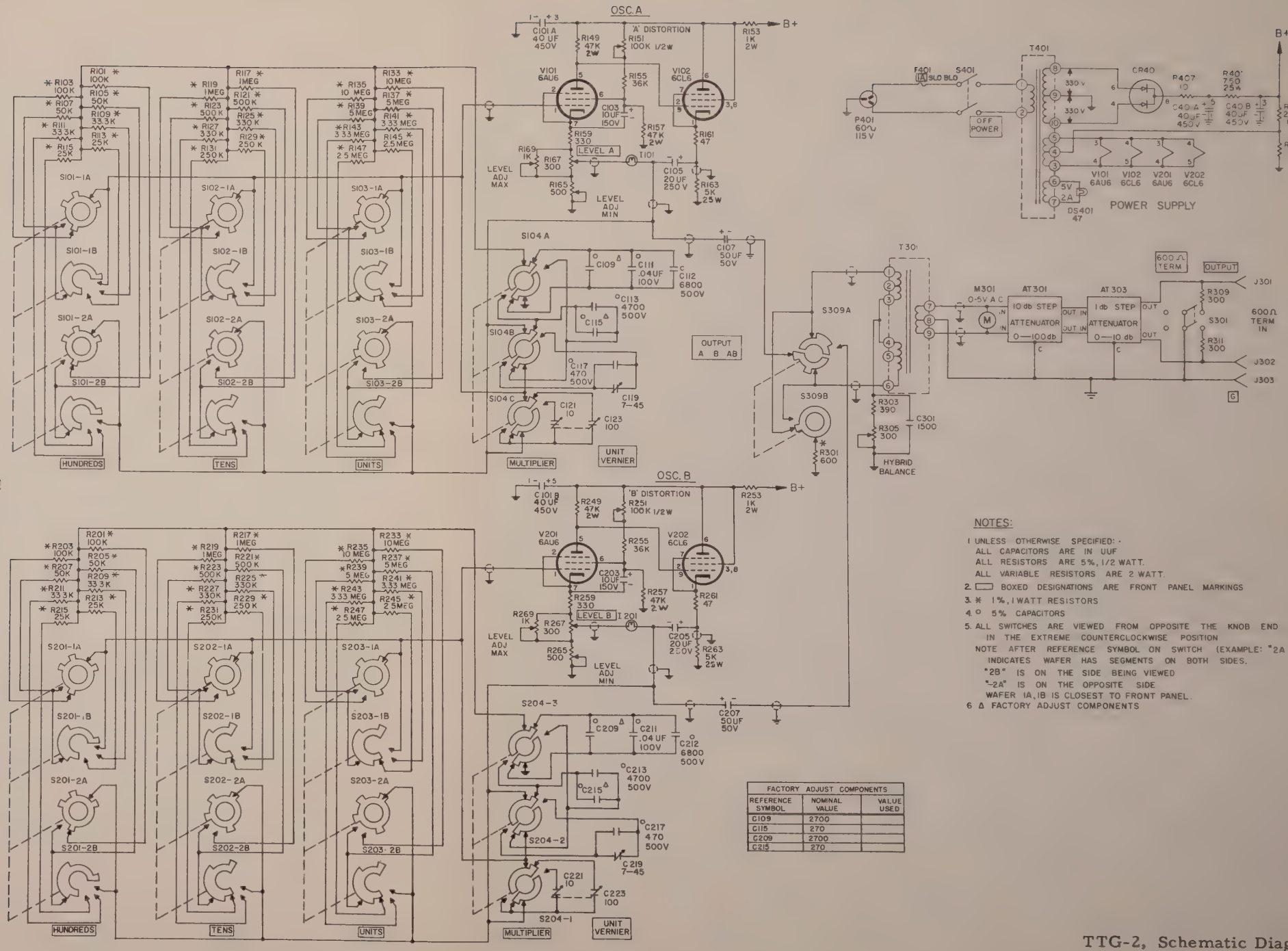
RF-7a, Variable Frequency Osc. 2.5 - 5.0MC Schematic



ATTENUATOR HEADS			
NO. OF GOLDBANDS	ATTENUATION	C1	C3
1	20 DB	0.3–5 UUF	-
2	40 DB	0.3–5 UUF	90UUF
3	60 DB	0.3–5 UUF	360UUF

PRB-2, Cathode Follower Probe Schematic

SB-12bS Schematic Diagram



NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   ALL CAPACITORS ARE IN UUF
   ALL RESISTORS ARE 5%, 1/2 WATT.
   ALL VARIABLE RESISTORS ARE 2 WATT.
2. ▭ BOXED DESIGNATIONS ARE FRONT PANEL MARKINGS
3. * 1%, 1 WATT RESISTORS
4. ○ 5% CAPACITORS
5. ALL SWITCHES ARE VIEWED FROM OPPOSITE THE KNOB END IN THE EXTREME COUNTERCLOCKWISE POSITION
   NOTE AFTER REFERENCE SYMBOL ON SWITCH (EXAMPLE: "2A", "2B") INDICATES WAFER HAS SEGMENTS ON BOTH SIDES.
   "2B" IS ON THE SIDE BEING VIEWED
   "-2A" IS ON THE OPPOSITE SIDE
   WAFER 1A, 1B IS CLOSEST TO FRONT PANEL.
6. Δ FACTORY ADJUST COMPONENTS

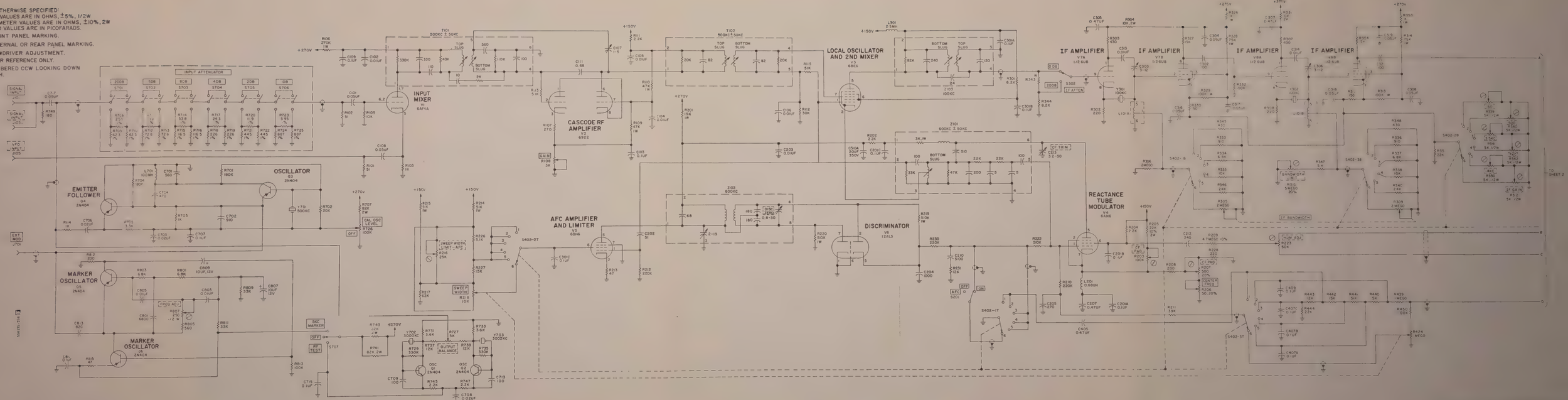
FACTORY ADJUST COMPONENTS		
REFERENCE SYMBOL	NOMINAL VALUE	VALUE USED
C109	2700	
C115	270	
C209	2700	
C215	270	

556155-207 [06]

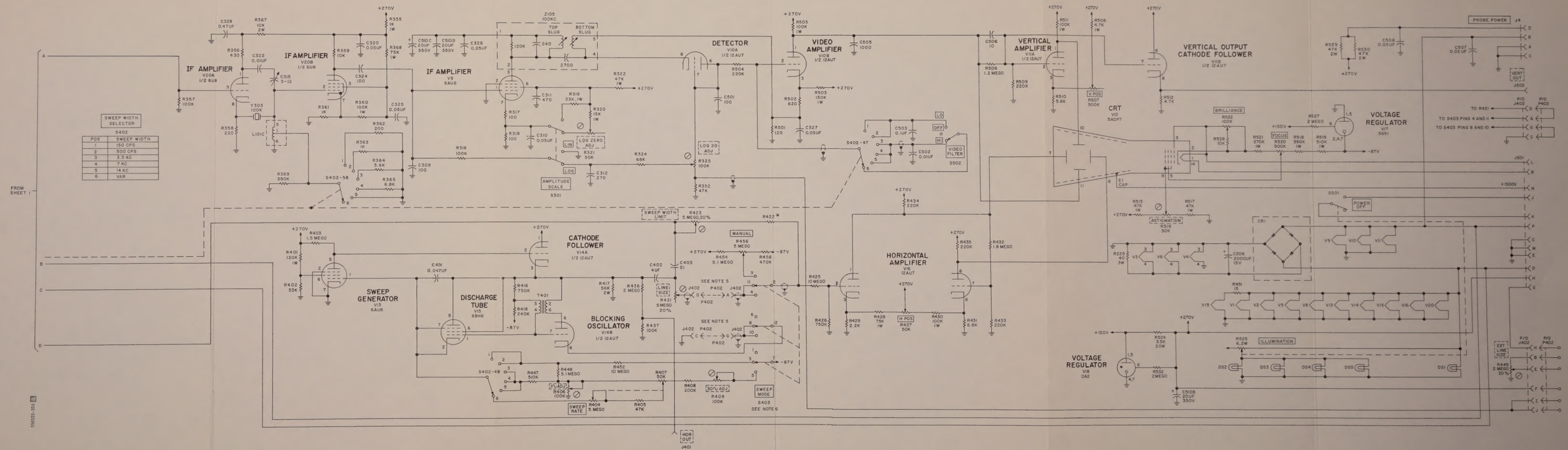
TTG-2, Schematic Diagram

NOTES:

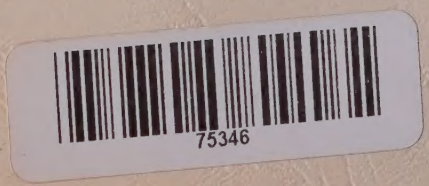
1. UNLESS OTHERWISE SPECIFIED:
   RESISTOR VALUES ARE IN OHMS, ±5%, 1/2W
   POTENTIOMETER VALUES ARE IN OHMS, ±10%, 2W
   CAPACITOR VALUES ARE IN PICOFARADS.
2. ▭ FRONT PANEL MARKING.
3. ▭▭ INTERNAL OR REAR PANEL MARKING.
4. ⌀ SCREWDRIVER ADJUSTMENT.
5. SHOWN FOR REFERENCE ONLY.
6. PINS NUMBERED CCW LOOKING DOWN AT SWITCH.



Schematic Diagram, Model SB-12bS (Sheet 1 of 2)



Schematic Diagram, Model SB-12bS (Sheet 2 of 2)


75346